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EDITH H. QUIMBY

President of the American Radium Society, 1953-1954

THE AMERICAN JOURNAL OF ROENTGENOLOGY
RADIUM THERAPY AND NUCLEAR MEDICINE

VOL. 72 NOVEMBER, 1954 No. 5

THE CLINICAL RADIATON PHYSICIST—A SPECIALIST WITHIN THE FIELD OF RADIOLOGY*

By EDITH H. QUIMBY
NEW YORK, NEW YORK

IT IS with combined humility and pride that I stand before you today to address you as your President,—humility because I am deeply conscious of the tremendous honor you have done me in electing me to this high office; pride, for myself, that you have thought me worthy, and for the Society, that you have taken the forward-looking step of recognizing equality in professional status for certain groups of medical and non-medical workers in the field of radiology. Your membership has long contained the leading radiologic physicists of the United States; they have served the Society diligently and well. They have been deserving of equal recognition, and you have been the leaders in this country in establishing it.

Radiologic physics as a special discipline apparently started in England, with Professor Russ, who went to the Middlesex Hospital as a research fellow in this field in 1909. In 1915 Dr. Failla started his work at the Memorial Hospital; so far as I can discover, Dr. Russ was still the only other full-time clinical radiation physicist. Prominent physicists in England, in Germany, and in the United States were, to be sure, concerned with roentgen rays and radium, although not directly from the clinical point of view.

Dr. Failla's investigations were interrupted by World War I. After the Armistice he returned from military duties in Europe with plans for developing a real radiological research laboratory at the Memorial Hospital, and in search of an assistant. I was fortunate enough to apply for this position and to be accepted; the association thus begun almost thirty-five years ago has continued happily until the present time,—and we have surely witnessed astonishing developments in the field.

Within the next three years, Stenstrom at the New York State Institute for the Study of Malignant Disease, Weatherwax at Philadelphia General Hospital, and Glasser, with Fricke, at the Cleveland Clinic, began the development of radiation physics departments that have steadily contributed to the science of radiology. In this period also Sievert started his work at

* President's Address delivered before the Thirty-sixth Annual Meeting, American Radium Society, Hot Springs, Virginia, March 14–16, 1954.

the Radiumhemmet, and Dessauer his in Frankfurt. Before the end of the decade two figures entered the picture who have occupied dominating positions ever since, Lauriston Taylor at the National Bureau of Standards, and Mayneord at the Royal Cancer Hospital in London.

For a time after that the group increased slowly. In England, Gray has stated that when he entered medical physics in 1933 there could scarcely have been more than half a dozen physicists in the field; presumably he was referring to British ones.[1] By that date, in the United States, Braestrup, Corrigan, Henny, Williams, and possibly a few others, had joined hospital staffs. However, in neither country was there any rapid expansion. Hospital physics, or radiological physics, was not really a recognized profession; there was no stabilized idea of the best basic training, and no university offered it as a specialty. Those in the field turned out an impressive amount of work, mostly on measurement and dosimetry of roentgen rays and gamma rays. They trained their assistants on an apprenticeship plan; several of these have gone on to become radiologic physicists of considerable stature.

The American Radium Society had been founded in 1916, by a group of physicians "to promote the scientific study of radium and other sources of ionizing radiation in relation to their physical properties and their therapeutic applications." (I quote from the constitution of the Society.) No physicist was a charter member, but Dr. Failla was invited to become an associate member in 1918. Stenstrom and I joined him in 1925, and from then on a steadily increasing group has come to our meetings and sought membership. Today there are about 290 active medical members of the Society, and 10 active members who are physicists. Of the medical members, about 80, or 28 per cent, are connected with institutions having radiological physicists,—although it is quite probable that not all of these avail themselves of the opportunity for cooperation.

Two years ago Dr. Roberts, Professor of Physics in Medicine at the Middlesex Hospital in London, gave his presidential address before the British Institute of Radiology on the subject "Is your Physics Really Necessary?"[2] I am sure that if a vote were taken in this audience on this question, the answer would be overwhelmingly "Yes." We might continue, "Are radiological physicists really necessary?" and I am sure we would again have an emphatic "Yes." But if the obvious next question were asked, "Why?" I doubt if we would have such unanimity.

Yet it is important for us to know the answer to this. If radiologic physics is to grow and assume a secure place as a definite specialty, we must know what is wanted and needed from such a specialist.

Answers will vary, from the response of the radiologist who wants a sort of supertechnician to keep his roentgen-ray machines calibrated and do fairly elementary dosage calculations, to that of the University President or Dean, who wants someone of top professional caliber to head a radiological research department. Obviously neither of these is the truly representative picture.

Let us look at the situation in a hospital with a busy radiotherapy department, where roentgen-rays, radium, and radioactive isotopes are employed. The things expected of the physicist might be considered under several heads, as follows:

1. Calibrations. Measuring the output of roentgen tubes and determining half-value layers is only part of this. The calibrating instruments themselves, such as ionization chambers, electrometers, Geiger counters and scalers, must be kept in good operating condition and their constancy assured. Centering and proper mounting of diaphragms, penumbra effect and the influence of cone walls may need to be studied. Beam directing devices must be checked; various allied problems may arise.

2. Roentgen-ray dose planning. This starts with seeing the actual patient with

the radiologist, securing any necessary anatomical outlines, having the lesion properly located on the anatomical chart, and the dose to the lesion prescribed by the radiologist, who also specifies limiting doses for regions to be avoided. From this start, the best method of delivering the needed dose is determined, and it is made sure that the plan is a feasible one. This includes arranging the use of beam-directing devices, moulds, etc., and implies the presence of the physicist at the actual setting-up of the patient, if any difficulties are to be anticipated. Routine of the department will determine whether he is customarily there, or whether residents do most of the regular setting-up.

3. Radium dose planning. The start here is the same as for roentgen-ray dose planning. A further step with radium is checking the implant for accuracy and adequacy after it is made, suggesting possible modifications, and spot-checking doses at specified points. The construction of any special moulds or applicators, of course, comes in this category.

4. Radioisotope calibration, dispensing, and measurements. In this section it is more difficult to set forth precise ideas, since so many variations are possible. However it must be assumed that the physicist has wide familiarity with the field. This will include as a minimum the various most commonly employed tracer or diagnostic techniques, such as those for the study of thyroid function and blood volume; it will also include such therapeutic procedures as the intracavitary administration of radioactive colloids. Adequate knowledge of the techniques and the statistics of counting is requisite. There should also be a good knowledge of the current literature in medical uses of these materials.

5. Radiation protection—roentgen rays, radium, radioactive isotopes. There are many facets to this. First is the ability to determine whether protection or safety precautions are adequate; this includes making any desirable measurements, and deciding on the need for use of film badges, blood counts, or other checks. Knowledge of proper handling methods for radium and isotopes at all practical levels is essential, and of procedures for decontamination or cleaning up after radioactive spills. It is necessary to know how to look for lost radium, and to specify what precautions must be taken in embalming or performing autopsy on an individual who has died within a short time after isotope therapy. Under this heading also comes instruction of nurses and other personnel in caring for patients with radium or other radioactive materials within their bodies.

6. Resident training. Since the candidate for any diploma of the American Board of Radiology involving therapy must take an examination in radiologic physics, it is obviously the duty of the physicist to see that he is prepared for it. This may include some didactic teaching, but it should also provide actual practice in the use of instruments for the making of calibrations and of isodose charts, and of isotope measurements, together with a good variety of dosage calculations.

7. Research. Probably not more than a third of all radiologic physicists will do real research. This does not mean that they will not make measurements with phantoms, or investigate small practical problems. Every one of them should be prepared for this. They should also be ready and able to cooperate with individuals from other departments, who are making studies dependent on radiation. For example, if someone is irradiating animals, he should feel assured that the field is correct, and correctly set up, doses properly calculated, scatter eliminated or accounted for, etc. With isotopes, especially, the need for cooperation will probably be institution-wide. These activities do not really constitute research, and the content of a real research program is outside the scope of these remarks.

Needless to say, the person who is prepared to do all this must have a broad education both in the basic sciences and in their practical applications within the field of medical radiology. Basic physics, atomic

and nuclear physics, and electronics, some chemistry, anatomy, and physiology, are probably the academic minima; at least a year of close practical association within a clinical department would seem essential, with some real responsibility for a part of the work; a personality such that a cooperative program seems the most interesting way of working is highly desirable.

This man or woman is not a technician, nor even a supertechnician; but a professional person, and should be treated as such. His career is in radiology, as an active partner of the radiotherapist. He has no desire to supersede the radiologist, or to take over the treatment of patients, but he does want a defined position within the field of his choice.

What should a trained radiation physicist expect in this regard? First of all, a definite staff position. Its level is of course to be determined by his training and experience. In an academic institution it would be instructor, assistant or associate professor, or full professor of physics in radiology (or other acceptable title), with the same possibilities of advancement as his medical colleagues have. In a non-academic hospital, such titles as junior, assistant, or associate physicist, or simply physicist would be used. His responsibility is to his department chief, just as is the responsibility of the medical members of the department. Second, satisfactory working conditions. This means, on the professional side, a definite responsibility within the department, together with complete inclusion in all general departmental activities. The partition of responsibility for treatment planning between radiologist and physicist should be definitely understood; the physicist should be encouraged to see the patients at follow-up to learn the results of the planned treatments. He should take active part in clinical conferences, when his special skills and knowledge may on occasion be very valuable. Arrangement should be made for his doing his share of resident training, not on a catch-as-catch-can basis, but as a regularly scheduled activity of the department. On the physical side, satisfactory working conditions include some place affording privacy for studying, writing, or carrying out certain experimental work. Office and laboratory may be combined in one room, but in this case it should not be a general or teaching laboratory for the department staff. There should be adequate equipment, including some shop facilities. Third, an adequate salary, commensurate with other academic or institutional salaries at his level.

Once a radiologist or an institution has decided that a physicist is needed, and has established a position for him, how can it be assured that the candidate fulfils their conditions? Of course the best way is by actual previous knowledge of and association with the individual. This is seldom the situation; then personal interviews, and discussions with teachers or previous employers are helpful. However, the American Board of Radiology has taken a really constructive step in setting up diplomas in radiological physics, or in one of its sub-classes, roentgen-ray and gamma-ray physics, or medical nuclear physics. The requirements for admission to the examination up to the present time have been a bachelor's degree in physics, chemistry or engineering, and two years of post-graduate work in the field of radiation physics, one year of which must have been spent in association with a radiation therapy department approved by the Board. During these post-graduate years the candidate is expected to have taken some applicable academic work, and to have obtained some additional laboratory facility in his chosen field, in addition to his clinical experience.

It must be accepted that these requirements represent an absolute minimum of achievement, and that one who expects to arrive at any recognized status in his profession will go much farther. The same idea holds for the practicing radiologist; requirements for admission to the examination are minimum. It is not expected that everyone who receives his diploma is qualified to be a professor, or even to do independent re-

search. These, in medicine also, are subsequent steps beyond the minimum. But there is no suggestion of a first-class and a second-class diploma.

However, it now appears that the Board originally set its qualifications for the physicists somewhat too low. A committee is studying the entire picture, to try to find out how best, on the one hand, to make sure for the radiologist that the candidate has at least minimum competence in the field, and on the other, to give to the physicist a definite professional recognition. The result will probably be requirement of a somewhat longer period of post-graduate training, both at practical and academic levels. Content of knowledge, rather than any specific university degree, should be looked for. To this end, a more rigorous examination should be given. Detailed steps in this regard will probably be taken during the coming year.

It should be of interest to review the list of diplomates of the Board, in the five years or so during which examinations have been held. At the present time about sixty physicists have been certified. Sixteen have diplomas only in roentgen-ray and gamma-ray physics, and three in medical nuclear physics; all the rest hold the full diploma in radiologic physics. Of the total, about one-third have offered minimum qualifications, another third hold doctor's degrees, the remainder had a considerably greater amount of experience or education than the minimum. Of the third who entered at the minimum level, several are continuing to work toward higher academic degrees and all, so far as I know, are rendering competent service to their departments. Ten of the sixty are now in positions not affiliated with clinical departments. Twelve are in hospitals having more than one diplomate on the staff. Ten have professorial appointments, and are presumably doing or directing research; all of these are in institutions where there are other diplomates, or physicists-in-training, or both.

This is the present certified supply. Let us look for a moment at the other side of the picture, the probable demand. There are about 70 medical colleges in the United States, and probably an additional 250 hospitals approved for training in radiology. There are about 2,200 diplomates of the American Board of Radiology in either Radiology or Therapeutic Radiology. Board diplomates in physics at present supply full-time or part-time physics to possibly 50 of these institutions (not including infrequent calibrations as "physics"); another 20 may have non-Board physicists. Some of these have more or less active cooperation with academic departments of physics. (In some instances cooperation started in this manner has led to very real interest in medical work, and to the addition of valuable members to the clinical physicists' group.) However, it is probable that three-fourths of the hospitals have either no physics or inadequate part-time coverage. Also probably three-fourths of the diplomates in Radiology or Therapeutic Radiology are not affiliated with hospitals having physicists on their staffs.

Thus it is evident that the present supply of physicists is not nearly adequate. Yet if the earlier question "Are radiologic physicists really necessary?" is answered in the affirmative, then it seems that a way must be found to attract more men and women into the field, and to give them the proper training for it.

We are accustomed to thinking of England as the land of special opportunities for the physicist, and I thought they might have some wide program for attracting candidates and training them, so I wrote to a good friend of mine there, a professor of medical physics, asking for some detailed information. He gave me no royal road to the problem, but some interesting facts.

They have no specific means of attracting men into the field, and no definite undergraduate or graduate academic program leading to the work. The majority of entrants into hospital physics come straight from graduation at the universities and take junior appointments in hospitals or medical schools, although some come in af-

ter a period of working in industry. Training is practically always in the nature of an apprenticeship. In general, in the hospitals, two years of such apprenticeship are necessary before confirmed appointment is made at the basic grade, and three more for qualification as Senior Physicist; however, experience or demand may shorten these periods. There is no examination; advancement is based mainly on recommendation of supervisors and heads of departments.

Some statistics on membership in the British Hospital Physicists Association may be interesting for comparison with our own Board diplomates. At the time of my information there were 189 regular members; 136 of these were working in or closely associated with radiological departments. These will include some still in their basic two years; they will also include a considerable number doing development work, and a few making real research contributions. The remaining 35 are in medical schools and research organizations; most of these are involved in research to a greater or lesser degree. Some of these have a prime interest in radiology or radiobiology, but in general they represent the wider aspects of physics as applied to medicine. There are five university professors of physics in this field.

The British situation is now fairly well established; in the United States we are really trying to initiate a program. It must be a program based upon professional appeal and opportunity.

The attracting of suitable men and women into this work is a primary problem. At present, interest may be aroused in different ways, by a chance answering of an advertisement or a work call, by personal relations with someone already in the profession, or by hearing or reading about the opportunities. It is the stimulation of this interest that is to be desired, and the methods for doing so are not clear. Where there is close liaison between academic and medical departments much can be accomplished by demonstrations and lectures. Attendance at meetings of the national radiological societies would be most valuable, but it is not easy to see how this can be promoted as a career-stimulating program. Occasional presentations of radioclinical material are made at meetings of the American Physical Society, but they are likely to be lost in the vast array of papers; there is no section on biophysics. The programs and publications of the Radiation Research Society may help to arouse interest in clinical radiation physics; this organization is as yet too new to know just what are its potentialities. At present it appears that the attracting of candidates into this type of work will continue to be on an individual basis. Further growth will depend upon wider dissemination of information about career possibilities.

As to training, there are now a few institutions offering courses leading to the degree of Ph.D. in biophysics or medical physics. The individuals who complete this work surely are prepared for top positions in clinical radiation physics,—except for the lack of experience in a clinical department for which there is no substitute. It will be highly desirable to try to attract them into the medical field, but it is probable that most of them will be interested mainly in the academic or research type of appointment, in an institution where their juniors will do most of the day-by-day work of the radiation physicist.

A few institutions are attacking the problem at a somewhat lower academic level, trying to interest the science student during his undergraduate years. If during that period he could study the basic physics, chemistry and biology, then at the graduate level he could concentrate on especially appropriate material, and possibly also incorporate into the program for a master's or doctor's degree an "intern" year in the radiotherapy department affiliated with his university. It would appear that such a plan, developed with an understanding of the Board requirements, could be set up in several universities, with the cooperation of the departments of physics and radiology. In various places where arrangements

of this type have been worked out, the candidate may hold a part-time paid position in the radiotherapy department, while pursuing his academic work in the other part of his time. The radiotherapist assumes responsibility for an apprentice type of training, which should, however, be subject to some sort of supervision by a radiation physicist. At present physicists qualified to offer this supervision are concentrated in a few cities; they must be urged to find a way to extend their influence. As more of them become available, the program should be able to expand as needed.

The American College of Radiology might help to stimulate developments of this sort, and Associate Fellows of the College should take an interest in the type of position to which this training would lead, both as to professional status and salary. Anyone starting in this work should be encouraged to attend meetings of the radiological organizations, get acquainted with his co-workers and follow professional developments. Personal contacts with the "big names" in radiology, and "bull sessions" between programs, are very stimulating and first-hand information collected at these meetings may lead to interesting developments.

Like other groups of people, radiologic physicists want an organizational home, with its attendant responsibilities and privileges. They should be encouraged to find this home inside organized radiology, not outside it. A separate organization of physicists would be highly undesirable. What is needed is not segregation, but assimilation. And be assured that in this assimilation the broad interests of radiology will be best served. The records of all the national radiological organizations bear witness to the wide cooperation of the group of radiologic physicists, even restricted as they have been to associate memberships. It should now be the time to set up a system of memberships-elect, or associate memberships which will have as their ultimate goal full membership.

The American Radium Society has recognized this and has laid the foundation for this type of assimilation. About 3 per cent of their active membership is now composed of radiologic physicists. The other national organizations are watching the innovation. I predict that they will be pleased with what they see, and will follow your lead.

630 West 168th St.
New York 32, New York

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VENOGRAPHIC CLUES TO LOCALIZATION OF INTRACRANIAL MASSES*

By PAUL A. RIEMENSCHNEIDER, M.D., *and* ARTHUR ECKER, M.D.
SYRACUSE, NEW YORK

CEREBRAL angiography, introduced by Egas Moniz over twenty years ago, has come into common usage in this country. This diagnostic method is of unquestioned value, although there are many workers who doubt its accuracy as compared to intracranial air studies for a general survey. Hodges and his associates[4] have recently presented data showing that in their hands ventriculography was five times as valuable as cerebral angiography in localizing intracranial masses. All those who have had large experience with the procedure grant its merits not only in the recognition of vascular abnormalities but also in localizing expanding lesions in the frontal and temporal lobes and in the region of the optic chiasm. Masses in these locations readily cause a displacement of the internal carotid and/or the larger and more proximal portions of the anterior or middle cerebral arteries. Were it possible to discover other portions of the vascular bed as constant in position as these, the scope of usefulness of cerebral angiography could be considerably expanded. We have reported elsewhere[2] our experience with the localizing importance of the anterior choroidal, posterior communicating and posterior cerebral arteries.

The vast majority of angiographic literature deals with arterial changes alone except in discussions of the demonstration of tumor circulation and the presentation of dural sinus venography. Egas Moniz[3] in 1940 made reference to several changes in the deep venous system which aided him in tumor localization. Krayenbühl and Richter[5] in their excellent monograph have presented a detailed description of the changes seen in these veins. This report is simply a confirmation and amplification of these findings with selected examples from our series of over 600 angiographic examinations.

Our angiographic procedure has been presented in detail elsewhere.[1] While we have a roll film device available, we have had our best results with manual changing of cassettes allowing a four to six second interval between arteriographic and venographic phases. This permits us to use films made in multiple positions and stereoscopically without the danger of radiation overexposure to the patient. The surgeon and technical personnel are adequately protected by a long brass cylinder extending down to the head of the patient. By injecting about 12 cc. of 35 per cent diodrast into the carotid artery rapidly a satisfactory venogram can be obtained in most cases.

NORMAL CEREBRAL VENOUS ANATOMY

To recognize the abnormal changes in the venous system it is necessary to understand its normal anatomy (Fig. 1, 2, 3 and 4). Egas Moniz[3] has provided the basic knowledge of the course of these veins. His findings have been confirmed by Krayenbühl and Richter, and others. The internal cerebral vein originates at the interventricular foramen and is formed by the junction of the vein of the septum pellucidum, the thalamostriate vein (also known as the terminal vein) and the choroidal vein. The thalamostriate vein runs anteriorly, medially and inferiorly in the groove between the caudate nucleus and the thalamus, joins with the choroidal vein which courses in the choroid plexus of the lateral ventricle. Together they form an acute angle, passing medially and inferiorly through the interventricular foramen, where they are joined by the vein of the septum pellucidum and together become the internal cerebral vein. This point has been referred to as the

* From the Radiological and Neurosurgical Services of the Syracuse Memorial Hospital and the State University of New York, Upstate Medical Center, Syracuse, New York. Presented at the Fifty-fourth Annual Meeting, American Roentgen Ray Society, Cincinnati, Ohio, Sept. 29–Oct. 2, 1953.

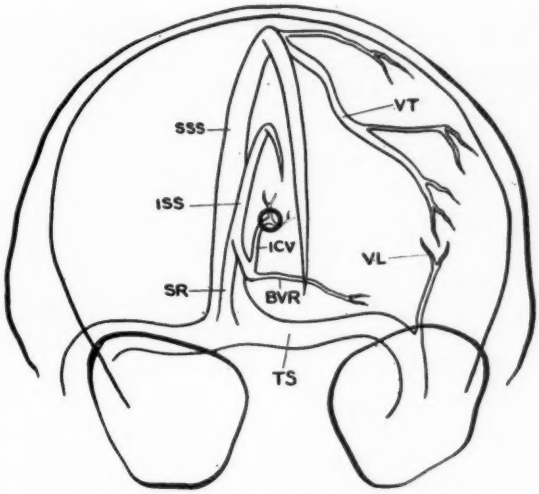

Fig. 1. Schematic representation of normal anteroposterior venogram. BVR, basal vein of Rosenthal; ICV, internal cerebral vein; ISS, inferior sagittal sinus; SS, SR, straight sinus; SSS, superior sagittal sinus; TS, transverse sinus; TSV, thalamostriate vein; VG, vein of Galen; VL, vein of Labbé; VSP, vein of septum pellucidum; VT, vein of Trolard. The circle corresponds to the position of the foramen of Monro.

"venous angle" by Krayenbühl and Richter.[5] Each internal cerebral vein passes backward in the tela choroidea of the roof of the third ventricle. Seen in the lateral projection it has a smooth curve which is convex upward. It then joins

Fig. 2. Normal anteroposterior venogram.

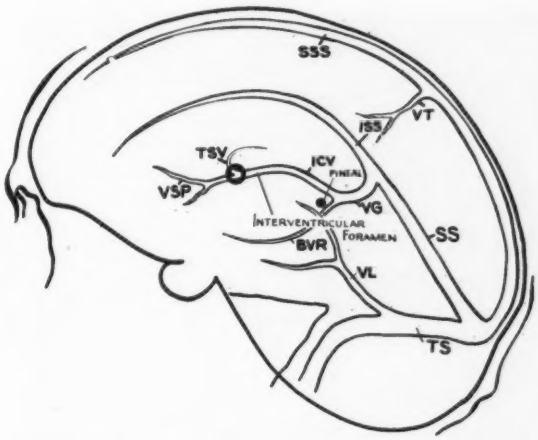

Fig. 3. Schematic representation of normal lateral venogram. (See Fig. 1 for explanation of letters.)

with its fellow of the opposite side to form the midline great vein of Galen. This follows a curve concave upward running posteriorly and joining the inferior sagittal sinus to become the straight sinus. The curve of the great vein of Galen is formed by the splenium of the corpus callosum around which this vessel runs. The pineal body is located about 7 mm. anteroinferior to the lowest point of the vein of Galen. When the pineal body is not calcified one can mark this position on venograms for use with the standard pineal charts. The inferior sagittal sinus runs a sickle-like course posteriorly roughly parallel to the inner table of the skull. It joins the great vein of Galen and, without changing direction, continues as the straight sinus which empties into the two lateral sinuses at the torcular. The basilar vein of Rosenthal

Fig. 4. Normal lateral venogram.

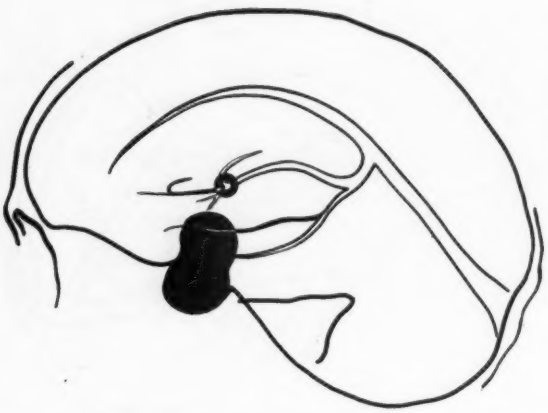

Fig. 5. Schematic representation of changes seen in lateral venogram with suprasellar masses. Note upward displacement of basilar vein and stretching of vein of septum pellucidum.

originates about the anterior perforated space, and runs posteriorly upward and medially with the optic tract around the cerebral peduncles. Usually it enters the great vein of Galen at its origin but may empty directly into the straight sinus.

Considering the anatomical structures in close proximity to these veins one would expect portions of these veins to be displaced by space occupying lesions of the basal ganglia, temporal lobes, cisterna chiasmatis, cerebellopontine angle, pineal body and posterior part of the corpus callosum. In addition, the great vein of Galen provides a midline structure which may be laterally displaced by posterior supratentorial masses which may not laterally displace the anterior cerebral arteries.

SUPRASELLAR TUMORS

Egas Moniz[3] describes an upward displacement of the basilar vein of Rosenthal seen in patients with large tumors deep in the middle fossa. Krayenbühl and Richter[5] do not mention displacement of the basilar vein by tumors in this area but describe an upward displacement of the "venous angle." All of our patients who had good sized parasellar extensions of suprasellar tumors showed some upward displacement and stretching of the basilar vein (Fig. 5 and 7). Because of the lateral position of the anterior portion of this vessel one would expect a considerable parasellar extension of a midline mass before displacement occurs.

In none of our venograms were we able to find a significant upward displacement of the "venous angle." Many showed an apparent stretching of the vein of the septum pellucidum also described by Krayenbühl and Richter.[5] Perhaps the failure to find this upward displacement is explained by the relatively small suprasellar extension of the tumors in our series. Several of our venograms of patients with meningiomas of the tuberculum sellae (Fig. 9) have shown similar although less marked changes. The major alteration in these has been a kinking of the anterior portion of the basilar vein as though from pressure along its axis. List and Hodges'[6] venogram of a patient with a sphenoid wing meningioma shows a similar change (their Fig. 36).

A-328. Male, aged sixty-one. Chromophobe adenoma of pituitary. Five month history of diplopia and bitemporal hemianopsia. Skull roentgenograms revealed a ballooned sella. Carotid angiograms showed typical upward displacement of the first portions of both anterior

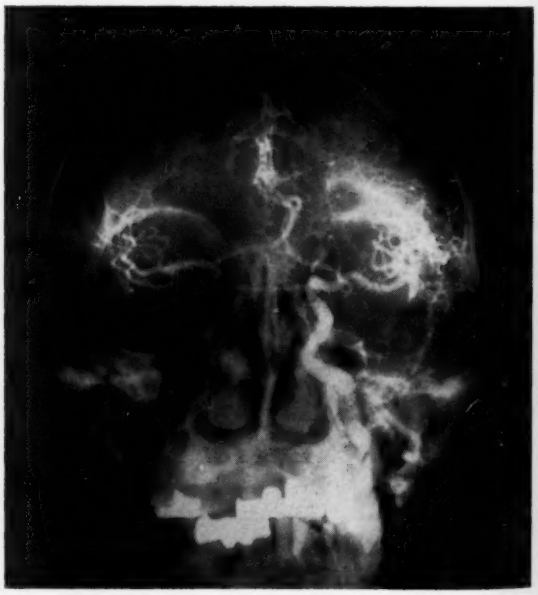

Fig. 6. A-328. Chromophobe adenoma of pituitary. Anteroposterior arteriogram showing upward displacement and stretching of first portion of anterior cerebral artery on each side. (Reproduced by permission from "Angiographic Localization of Intracranial Masses." By Arthur Ecker and P. A. Riemenschneider. Charles C Thomas, Publisher, Springfield, Illinois. In press.)

Fig. 7. A-328. Chromophobe adenoma of pituitary. Lateral venogram. The basilar vein is elevated and the vein of the septum pellucidum stretched. (Reproduced by permission from "Angiographic Localization of Intracranial Masses." By Arthur Ecker and P. A. Riemenschneider. Charles C Thomas, Publisher, Springfield, Illinois. In press.)

cerebral arteries (Fig. 6). The lateral venograms demonstrated an upward displacement of the anterior end of the vein of Rosenthal as well

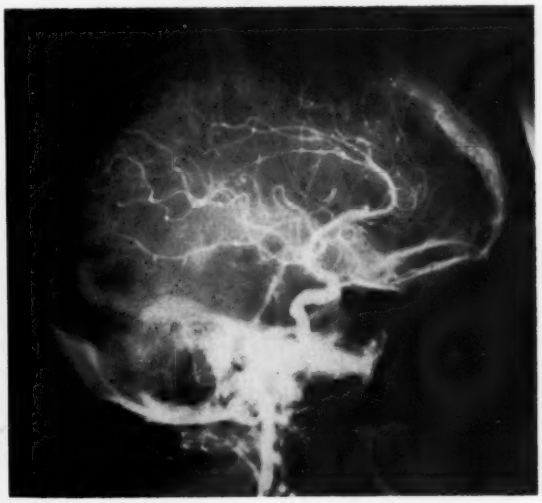

Fig. 8. A-229. Meningioma of tuberculum sellae. Lateral arteriogram. The anterior cerebral artery is displaced upwards and posteriorly by the presellar mass. (Reproduced by permission from "Angiographic Localization of Intracranial Masses." By Arthur Ecker and P. A. Riemenschneider. Charles C Thomas, Publisher, Springfield, Illinois. In press.)

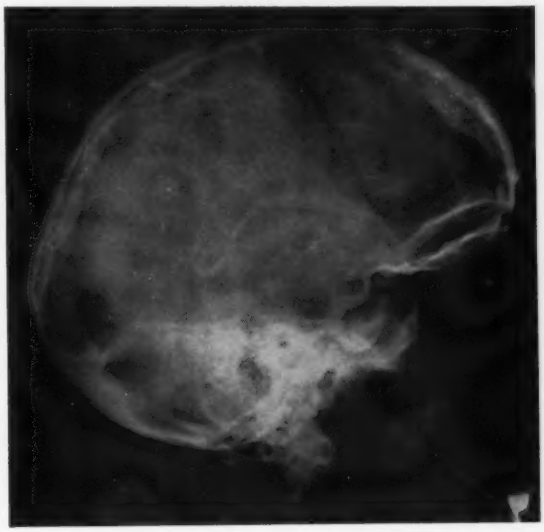

Fig. 9. A-229. Meningioma of tuberculum sellae. The changes seen in Figure 7 are again noted but there is in addition marked kinking of the basilar vein from pressure along its axis. (Reproduced by permission from "Angiographic Localization of Intracranial Masses." By Arthur Ecker and P. A. Riemenschneider. Charles C Thomas, Publisher, Springfield, Illinois. In press.)

as stretching of the vein of the septum pellucidum (Fig. 7). Operation revealed a mass bulging upward and forward out of the sella with considerable parasellar extension.

A-229. Female, aged sixty-five. Meningioma of tuberculum sellae. Complete loss of vision in left eye for three years. Progressive loss of vision in right eye for three months. Carotid angiograms showed upward displacement of the first portion of the anterior cerebral arteries and posterior displacement of second and third portions suggesting a presellar lesion (Fig. 8). Lateral venograms disclosed kinking and upward displacement of the anterior end of the vein of Rosenthal (Fig. 9). At operation a large meningioma of the tuberuclum sellae was found, about half of which was removed. This was followed by striking improvement in vision of the right eye.

FRONTOPOLAR TUMORS

Krayenbühl and Richter[5] have described a downward displacement of the "venous angle" with large lesions of the frontal pole. Our patients with tumors in this area have regularly shown downward and backward displacement of the origin of the internal

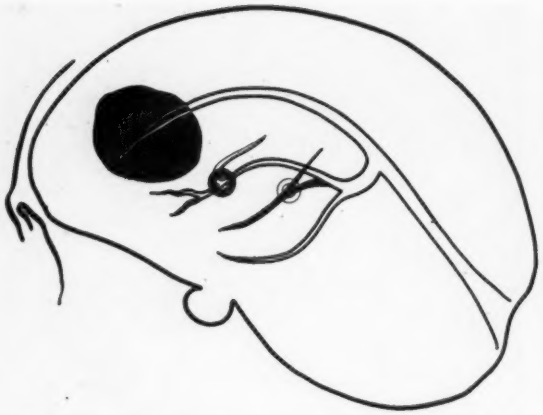

FIG. 10. Schematic representation of lateral venogram with a mass in frontopolar region. The foramen of Monro is displaced backward and downward. The internal cerebral vein is foreshortened and the "venous angle" extremely acute.

cerebral vein and consequently of the foramen of Monro (Fig. 10, 11, 12 and 13). Associated with this has been a downward displacement of the vein of the septum pellucidum and the thalamostriate vein, resulting in an extremely acute "venous angle." The internal cerebral vein appears markedly foreshortened in lateral venograms.

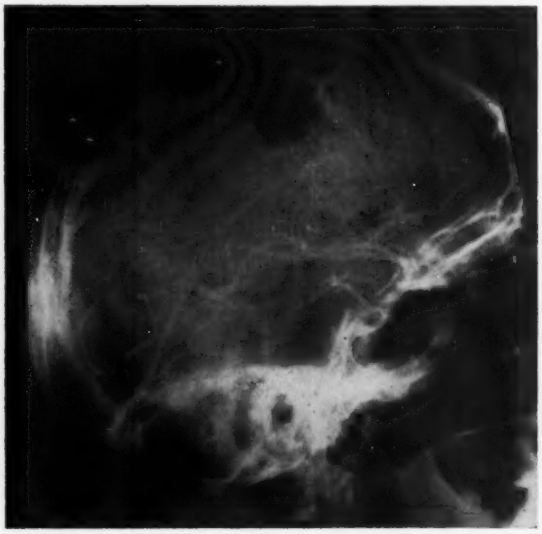

FIG. 11. A-386. Right frontal oligodendroglioma. Lateral venogram showing the changes seen in Figure 10. (Reproduced by permission from "Angiographic Localization of Intracranial Masses." By Arthur Ecker and P. A. Riemenschneider. Charles C Thomas, Publisher, Springfield, Illinois. In press.)

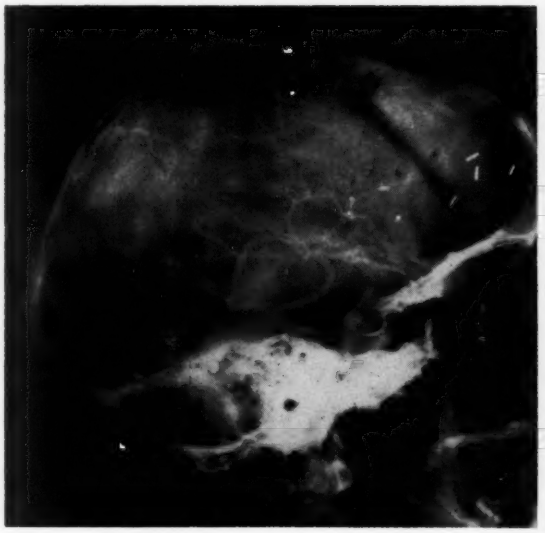

FIG. 12. A-203. Right frontal oligodendroglioma. Lateral venogram. There is marked foreshortening of the internal cerebral vein and posterior displacement of the "venous angle." (Reproduced by permission from "Angiographic Localization of Intracranial Masses." By Arthur Ecker and P. A. Riemenschneider. Charles C Thomas, Publisher, Springfield, Illinois. In press.)

A-386. Male, aged fifty-five. Right frontal oligodendroglioma. Left hemiparesis and ten year history of progressive left-sided jacksonian seizures. Cerebral angiograms and ventriculograms showed a large right frontal tumor. The lateral venogram demonstrates an acute "venous angle" with backward and downward displacement of the foramen of Monro. The

FIG. 13. A-181. Left frontal astrocytoma. Lateral venogram. The clips show the position of the tumor.

internal cerebral vein is markedly foreshortened (Fig. 11).

A-203. Male, aged forty-three. Right frontal oligodendroglioma. Confusion and irresponsibility following head injury. Cerebral angiograms showed a mass in right frontal pole. Craniotomy revealed a subcortical hematoma on medial aspect of right frontal pole. Microscopic report showed oligodendroglioma. The patient did well for several months and then returned with papilledema and elevation of bone flap. Repeat angiograms revealed a similar but more extensive change. The acute "venous angle" and marked foreshortening are clearly visible (Fig. 12). A second craniotomy was done with removal of a large right frontal oligodendroglioma.

A-181. Male, aged twenty-two. Left frontal astrocytoma. Six month history of weakness of right limbs with frequent attacks of diplopia, syncope, headache and dysphasia. Examination showed marked bilateral papilledema. Cerebral angiograms demonstrated changes consistent with a left frontal tumor. Craniotomy disclosed a 4 by 6 by 5 cm. avascular tumor which, when removed, proved to be an astrocytoma. Two years later symptoms recurred. Repeat angiograms demonstrated a change similar to that of the original examination. The lateral venogram is strikingly like those of the last 2 patients (Fig. 13). Craniotomy at this time showed recurrent tumor.

TUMORS OF ANTERIOR BASAL GANGLIA

Involvement of the head of the caudate nucleus and thalamus by tumor would be expected to change the "venous angle," opening it and elevating the thalamostriate vein and at the same time displacing the foramen of Monro downward and backward (Fig. 14 and 15). Krayenbühl and Richter[5] and we have seen these changes in deep, inoperable tumors. Occasionally the vein of Rosenthal also has been displaced backward and inferiorly. The striking feature has been the opening of the angle due to the elevation of the thalamostriate vein. On the contrary, frontopolar lesions typically show an acute angle due to the downward displacement of the thalamostriate vein.

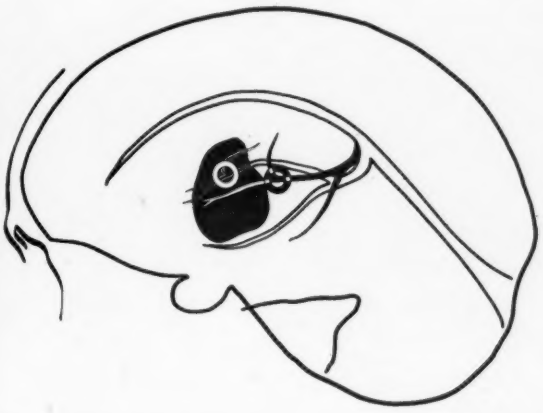

Fig. 14. Schematic representation of a tumor in the anterior portion of the basal ganglia. The foramen of Monro is again down and back but the "venous angle" is open.

Fig. 15. A-90. Hematoma in anterior portion of left basal ganglia. Lateral venogram. There is marked foreshortening of the internal cerebral vein but an extremely obtuse "venous angle." Compare with Figures 11, 12, and 13.

A-90. Male, aged sixty-one. Hematoma in anterior portion of left basal ganglia. Recurrent episodes of transitory aphasia and weakness for over two years. Four days before admission, fall followed by persistent aphasia, right hemiplegia and stupor. Cerebral angiograms revealed displacements consistent with a mass in the rostral portion of the basal ganglia. The lateral venogram shows the elevation of the thalamostriate vein and posterior displacement of the abnormally obtuse "venous angle" (Fig. 15). A needle was inserted through a left temporal burr hole and 50 cc. of blood were removed. The patient died. No autopsy was obtained.

FIG. 16. A-79. Left parieto-parasagittal astrocytoma. Lateral venogram. The curve of the vein of Galen is flattened and there is an upward concavity of the inferior sagittal sinus. The calcification in the tumor is visible just above this point.

PARIETO-PARASAGITTAL TUMORS

Large parieto-parasagittal tumors might be expected to flatten the vein of Galen. This change is illustrated by Egas Moniz[3] in his Figure 162. We have occasionally seen it and also an apparent depression of the inferior sagittal sinus with a concavity upwards. This change is more difficult to explain because of the attachment of the sinus to the falx (Fig. 16).

A-79. Male, aged forty. Left parieto-parasagittal astrocytoma. Right-sided seizures and left-sided headache for three months. Roentgenograms of the skull showed a calcified mass 3 cm. in diameter in medial portion of left parietal lobe. Cerebral angiograms confirmed the presence of a space occupying mass in this region. The lateral venogram reveals a flattening of both the internal cerebral vein and an upward concavity of the inferior sagittal sinus (Fig. 16).

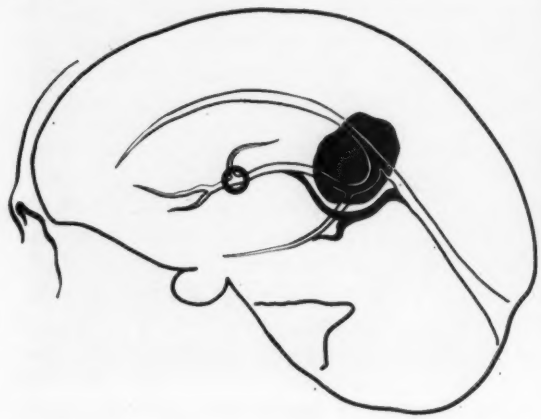

FIG. 17. Schematic representation of changes with tumors of posterior portion of corpus callosum. The marked ballooning of the vein of Galen is characteristic of this lesion.

TUMORS OF POSTERIOR CORPUS CALLOSUM

Egas Moniz[3] postulated that any tumor invading the splenium of the corpus callosum should produce a ballooning of the vein of Galen but stated that he had never had the opportunity to observe such a change. We have seen at least four such tumors where this ballooning provided an important clue to the inoperability of the tumor (Fig. 17, 18 and 19).

A-370. Male, aged fifty-five. Right infrasylvian astrocytoma invading the posterior corpus callosum. Frontal headache for five months. Confusion, severe right parietal pain and left hemianopsia for three weeks. Mild left spastic hemiparesis at time of admission. Cerebral angiograms showed a large right posterior temporal mass. We failed to realize at this time

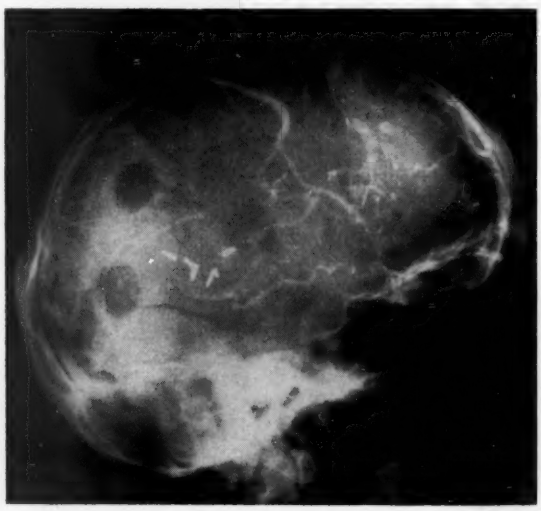

FIG. 18. A-370. Right infrasylvian glioblastoma invading splenium of corpus callosum. Lateral venogram. There is marked widening of the curve of the vein of Galen. The tumor position is shown by the clips. (Reproduced by permission from "Angiographic Localization of Intracranial Masses." By Arthur Ecker and P. A. Riemenschneider. Charles C Thomas, Publisher, Springfield, Illinois. In press.)

the significance of the ballooning of the vein of Galen. At operation a mass 5 cm. in diameter lying just lateral to the body of the ventricle was removed. There was progressive headache, confusion and drowsiness. Repeat angiograms again revealed the widened venous curve (Fig. 18). Three days later the patient died. Autopsy revealed massive extension of the tumor through the splenium of the corpus callosum to the opposite side.

A-397. Male, aged sixty-two. Left posterior callosal malignant tumor. Mental confusion and incoordination of right limbs for six weeks. The venographic changes were consistent with a mass in the splenium of the corpus callosum (Fig. 19). Surgical exploration was carried out to exclude the possibility of a benign lesion. In the left posterior callosal region liquefied tissue was found which mircoscopically showed anaplastic tumor cells. The patient died within a month.

Fig. 20. Schematic representation of changes seen with a subdural hematoma. The surface veins are displaced away from the skull. The venous angle is displaced laterally across the midline.

SUBDURAL HEMATOMAS

The major arteriographic findings in subdural hematomas have been well recognized for many years. These consist of a displacement of the anterior cerebral arteries across the midline and a separation of the small branches of the middle cerebral artery from

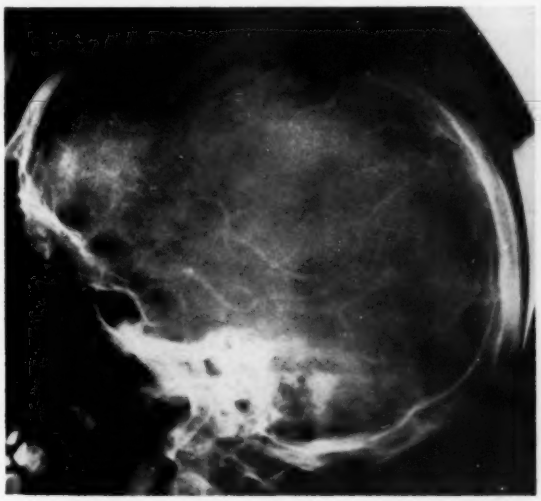

Fig. 19. A-397. Left posterior callosal malignant tumor. Lateral venogram. Note the generalized spreading of the curve of the vein of Galen. (Reproduced by permission from "Angiographic Localization of Intracranial Masses." By Arthur Ecker and P. A. Riemenschneider. Charles C Thomas, Publisher, Springfield, Illinois. In press.)

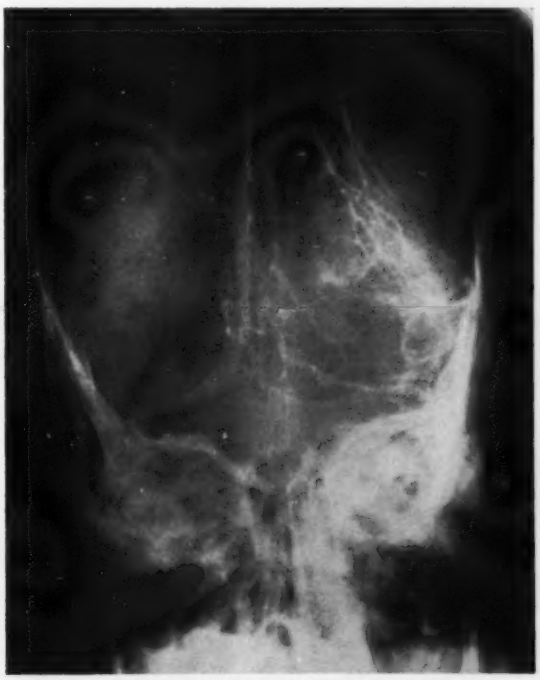

Fig. 21. A-405. Left parieto-occipital subdural hematoma. Anteroposterior venogram. The surface veins are depressed and there is displacement of the venous angle across the midline to the right. (Reproduced by permission from "Angiographic Localization of Intracranial Masses." By Arthur Ecker and P. A. Riemenschneider. Charles C Thomas, Publisher, Springfield, Illinois. In press.)

Fig. 22. A-208. Bilateral subdural hematomas, chronic. Anteroposterior venogram. The venous angle is in normal position. Compare with Figure 21. (Reproduced by permission from "Angiographic Localization of Intracranial Masses." By Arthur Ecker and P. A. Riemenschneider. Charles C Thomas, Publisher, Springfield, Illinois. In press.)

Fig. 23. A-495. Right parietal subdural hematoma. Anteroposterior view.

the inner table of the skull to which they are usually closely applied (Fig. 20, 21, 22, 23 and 24). Frequently the venograms will demonstrate more vividly the displdisplacement of veins from the inner table outlining the size and shape of the hematoma. The degree of displacement of the anterior cerebral arteries as compared to that of the midline veins will often show the point of maximum pressure from the hematoma.

A-405. Male, aged sixty-one. Left parieto-occipital subdural hematoma, subacute. Progressive weakness and inability to walk three weeks after automobile accident. Examination revealed severe ataxia, disorientation, slowness of thinking, impairment of recent memory and bilateral Babinski sign. Angiograms were typical of a left parieto-occipital subdural hematoma, which was subsequently evacuated. The anteroposterior venogram demonstrates the displacement of veins from the skull surface. The origin of the internal cerebral vein is displaced across the midline away from the mass (Fig. 21).

A-208. Male, aged fifty-eight. Bilateral subdural hematomas, chronic. Mild head injuries over a period of years. Right temporal headache for several months, twitching of right face for a few weeks. Angiograms demonstrated bilateral

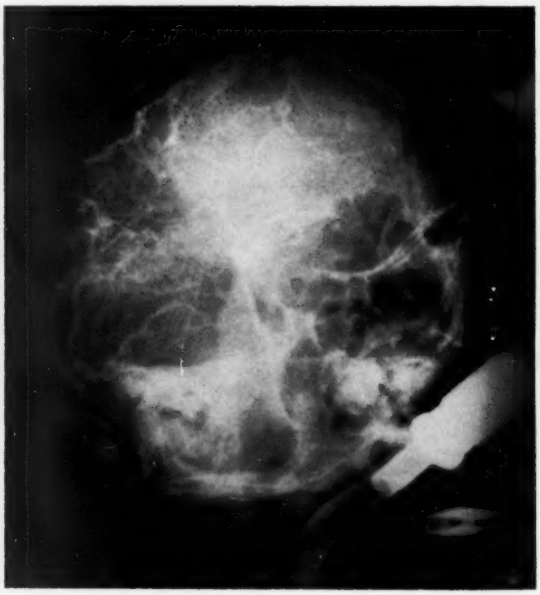

Fig. 24. A-495. Right parietal subdural hematoma. Half axial view. The location of the displaced surface veins is well seen in this projection.

subdural hematomas which were evacuated by bilateral burr holes. The anteroposterior view shows the bilateral masses (Fig. 22). The position of the origin of the internal cerebral vein in the midline should be compared with the roentgenogram of the previous patient.

A-495. Female, aged forty-eight. Left parietal subdural hematoma. Generalized headache for three weeks. No head injury. Examination revealed a left oculomotor paralysis. Roentgenograms of the skull showed the pineal shifted to the left. Angiography (Fig. 23 and 24) disclosed a large subdural hematoma over the right parietal area. Surgical evacuation was carried out with uneventful recovery.

TEMPORAL TUMORS

Tumors of the middle and posterior portions of the temporal lobe or extracerebral tumors in this general area tend to cause an upward displacement and humping of the basilar vein. This change is similar to that described with parasellar extensions of suprasellar tumors. However, in temporal masses the displacement is generally greater and with the maximum pressure exerted more posteriorly. We have also seen apparent upward displacement of the ampulla of Galen in several patients (Fig. 25, 28, 29 and 30). On occasions in patients with either temporal or occipital lesions the lateral displacement of the ampulla has provided the most reliable clue to tumor localization (Fig. 27). This sign has been particularly helpful in patients with no displacement of the anterior cerebral arteries, minimal asymmetry of the middle cerebral arteries and no evidence of calcification in the pineal body. A marked elevation of the vein of Labbé in a case of sarcoma of the temporal pole was described by List and Hodges[6] and illustrated by their Figure 23. Several of our venograms have shown a similar change.

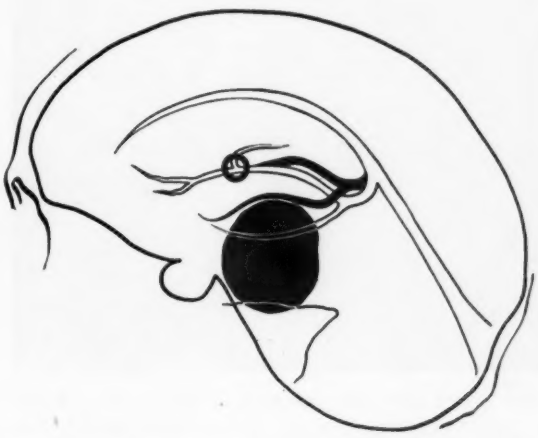

Fig. 25. Schematic representation of venographic changes with temporal lobe mass. There is marked upward displacement of the basilar vein.

Fig. 26. A-451. Meningioma of left middle fossa. Anteroposterior arteriogram. There is no evident displacement of anterior cerebral artery.

A-451. Female, aged twenty-one. Meningioma, left middle fossa. Progressive mental symptoms for ten months. Physical examination revealed left hemiparesis, including the left side of tongue and lower part of face. Deep reflexes were generally hyperactive, especially on the left. Left pupil larger than right. Right carotid angiograms were made because of the left hemiparesis. These appeared entirely normal except for definite displacement of the ampulla of Galen to the right (Fig. 26 and 27). Because this was presumptive evidence of a mass on the left side, left carotid angiograms were made. These showed a large vascular mass in the middle fossa on the left (Fig. 28). Opera-

Fig. 27. A-451. Meningioma of left middle fossa. Anteroposterior venogram. The ampulla of Galen is displaced across the midline to the right.

tion (elsewhere) required partial left temporal lobectomy. A rounded highly vascular tumor filled the middle fossa. Biopsy confirmed the diagnosis of meningioma. No attempt to remove the tumor was made. Five months later left spastic hemiparesis was still present.

Fig. 28. A-451. Meningioma of left middle fossa. Lateral venogram. The tumor is well outlined by its intrinsic circulation. There is marked upward displacement of the basilar vein around the tumor.

A-488. Female, aged forty-four. Chordoma. Four years previously an intracranial calcified lesion to the right of the posterior clinoid processes was observed. There had been progressive loss of vision in the right eye for a year and a half. For six months the right eye had turned inward. Examination revealed blindness and exophthalmos of the right eye with impaired external ocular movements. Vision of the left eye was 20/70 with a central scotoma. There was gradual slow enlargement of the calcified mass. Angiography demonstrated a mass extending upward from the dorsum sellae and stretching the right side of the circle of Willis. The lateral venogram (Fig. 29) showed marked elevation of the basilar vein. Surgery (elsewhere) revealed a chordoma, most of which was removed. Vision in the left eye improved to 20/20.

A-230. Male, aged fifty-three. Right middle temporal glioblastoma. Progressive right parietal headache, left quadrantanopsia, spastic hemiparesis and hemianesthesia. Plain roentgenograms of the skull showed the pineal shifted to the left and an irregular area of calcification in the right temporal area. Angiograms revealed a large avascular mass centered in the middle third of the right temporal lobe. The lateral venogram disclosed the marked humping of the middle third of the basilar vein and elevation of the vein of Labbé (Fig. 30).

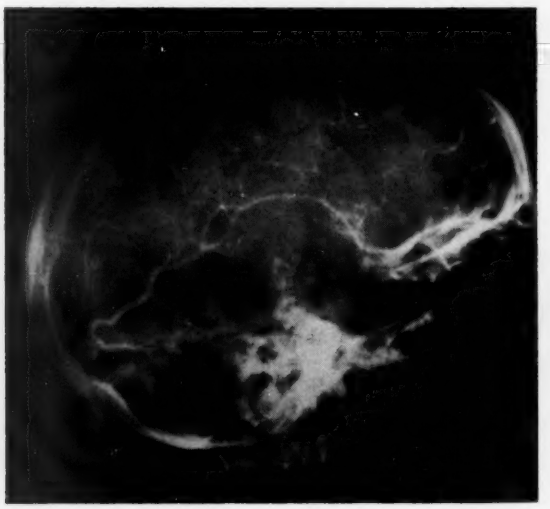

Fig. 29. A-488. Chordoma. Lateral venogram. The calcification in the tumor is easily visible. The basilar vein is markedly elevated and the vein of the septum pellucidum stretched. The vein of Labbé occupies an extremely high position.

Fig. 30. A-230. Right middle temporal glioblastoma. Lateral venogram. There is elevation and humping of the basilar vein. (Reproduced by permission from "Angiographic Localization of Intracranial Masses." By Arthur Ecker and P. A. Riemenschneider. Charles C Thomas, Publisher, Springfield, Illinois. In press.)

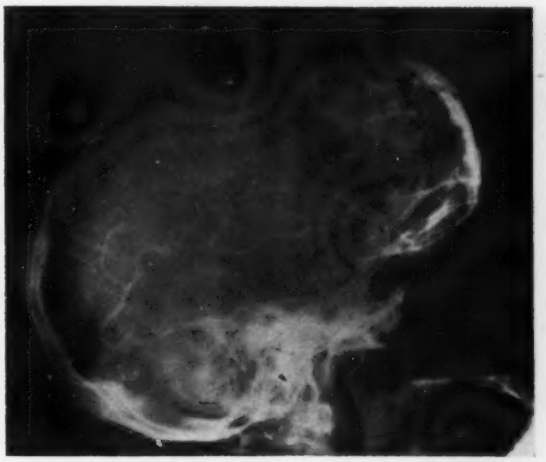

Fig. 32. A-285. Right acoustic nerve tumor. Lateral venogram. The hump in the curve of the vein of Galen is clearly seen. (Reproduced by permission from "Angiographic Localization of Intracranial Masses." By Arthur Ecker and P. A. Riemenschneider. Charles C Thomas, Publisher, Springfield, Illinois. In press.)

CEREBELLOPONTINE ANGLE TUMORS

The venographic changes resulting from large tumors in the cerebellopontine angle are similar to those described with masses in the temporal lobe. However, there is both stretching and a diffuse elevation of the basilar vein rather than the localized humping caused by temporal tumors. We have seen also a peculiar angulated hump of the origin of the vein of Galen in 2 patients with acoustic neuromas (Fig. 31 and 32).

A-285. Female, aged sixty-three. Right acoustic nerve tumor. Right-sided tinnitus with progressive deafness for two years. Plain roentgenograms of the skull showed erosion of the internal auditory meatus on the right. Right internal carotid and vertebral angiography confirmed the presence of a mass in the region of the right cerebellopontine angle. Transtemporal approach through the tentorium permitted sub-

Fig. 31. Schematic representation of changes in venogram with tumors of cerebellopontine angle. The basilar vein is elevated and there is a peculiar angulated hump at the origin of the vein of Galen.

Fig. 33. Schematic representation of changes with tumors of the pineal body. Enlargement of the pineal causes upward displacement of the anterior portion of the vein of Galen.

Fig. 34. A-426. Pinealoma. Lateral venogram. There is upward displacement of the anterior end of the vein of Galen. (Reproduced by permission from "Angiographic Localization of Intracranial Masses." By Arthur Ecker and P. A. Riemenschneider. Charles C Thomas, Publisher, Springfield, Illinois. In press.)

total removal of the tumor. The lateral venogram shows the upward displacement of the basilar vein and the peculiar hump at the origin of the vein of Galen (Fig. 32).

PINEAL TUMORS

Egas Moniz[3] in his Figure 161 shows an upward convexity in the curve of the vein of Galen in a patient with a pineal tumor (Fig. 33 and 34). We have seen this change in 2 patients. It is apparently peculiar to patients with abnormal enlargement of the pineal.

A-426. Female, aged forty-three. Pinealoma. Headache and vomiting for several months. Impairment of upward gaze and papilledema. Lateral arteriograms showed evidence of marked hydrocephalus. Lateral venograms demonstrate characteristic upward and backward displacement of the origin of the vein of Galen (Fig. 34). Ventriculography confirmed these findings. Operation revealed a pinealoma 2 cm. in diameter which completely obstructed the aqueduct.

SUMMARY

The normal cerebral venographic anatomy has been briefly described. The deep veins of the brain form such a constant pattern that certain deviations from the normal can be interpreted as significant. Examples of such displacements have been presented. These venographic alterations can be the most significant clue in the localization of intracranial masses and the determination of their operability.

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DISCUSSION

Dr. Arthur E. Childe, Winnipeg, Canada. In my opinion, this paper by Drs. Riemenschneider and Ecker is a very important contribution to the subject of cerebral angiography and I would like to congratulate them most heartily. In many ways it reminds me of several excellent papers published in the early 1930's by the late Dr. Cornelius Dyke and Dr. Leo Davidoff describing the basal cisterns and other anatomic structures, which did so much to help us understand pneumoencephalography more completely, and at times to diagnose lesions which cause little if any deformity of the ventricular system. Up until now I am afraid that, in the study of cerebral angiograms, many of us have devoted most of our attention to the arterial phase and to the presence or absence of tumor clouds and have failed to observe the

clues provided by the venous channels such as they have described. Perhaps we have felt that the deep veins were inconstant and variable but more probably we have merely forgotten to scrutinize them carefully. Certainly it would seem that they are just as constant in their location and no more variable in development than is the arterial tree.

I am very happy to hear that the authors favor stereoscopy in cerebral angiography. It seems to me that anything that is observed in single films is visible to better advantage in stereoscopic films, and that many structures which cannot be recognized with certainty at all in single films can be identified readily in stereoscopic films.

One of the easiest landmarks to recognize in the lateral venogram is the so-called "venous angle" which indicates the site of the foramen of Monro. As we know from cerebral pneumography and as Dr. Riemenschneider has shown us, it can be displaced by space occupying intracranial lesions situated in various locations. Often it is difficult to decide whether this angle is situated in a normal position or whether it is shifted slightly. I had hoped that the authors would have devised some type of chart, possibly similar to the well known pineal charts, which would enable one to compute whether it was situated in the normal zone or outside it. Possibly they will do this in a future communication.

THE SIZE OF THE SELLA TURCICA BY AGE AND SEX

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IN DESCRIBING the size of the sella turcica, clinical roentgenology resorts to either simple inspection, or to measurements of its diameters. Banal terms of simple inspection of common usage are justified in the practice for stereotyped average sizes and for obvious enlargements. The pertinent information is more comprehensive and more reliable, however, if the size is actually measured. Measurements of the area are more efficient than those of mere diameters. The expression of sellar size by using one number of the area is more suitable for constitutional and anthropological tabulation, graphic representation, and for clinical comparisons, than by using two numbers of the diameters. Therefore, the author proposed a method[14,48] to measure the area of the lateral projection of the sella in terms of square millimeters. Many authors have used this method since, mainly in Europe, for endocrine and constitutional investigations and clinical examinations.[2,3,4,6,7,9–13,22,23,24,26,28–37,39–50] The clinical usefulness of the method is, perhaps, best indicated by the words of Hurxthal:[26] "The method has merit especially in comparing the size of the sella from time to time in an individual case." "A larger number of cases showing an enlarged sella will undoubtedly be found by this method in comparison to the usual method of measuring diameters." For his recommendation Hare *et al.*[22] and Ziskin[50] applied the method in their publications. The procedure being generally unknown in this country, it seems appropriate to deal with its technique and with its application in a more detailed fashion.

METHODS

The *technique* is as follows: The contour of the sellar projection is traced on a transparent glass plate, lucite sheet, or cleared roentgen film. One of the heavier lines of a transparent squared millimeter paper or rule is superimposed on the upper limits of the sellar contour, or the tracing can be placed on the millimeter graph paper in a similar fashion. The procedure becomes more expedient when the heavier lined centimeter divisions or its main square subdivisions (50, 25, 10, and 5 sq. mm.) fall within the limits of the sellar tracing. A count is thereby obtained in a matter of seconds by simply adding or subtracting the single or broken square millimeters which do not fall within the confines of these square subdivisions.

Sartorius[41] has recommended eliminating the tracing by placing the millimeter paper directly upon the roentgen film for measurement. It is presumably a quicker method. However, since there are frequently many confusing contours, one cannot be certain that he is selecting the correct outlines in the course of the direct counting. Only by tracing the outlines can one be certain that the correct contours are being used.

It is possible to trace the sellar outline directly on the graph paper. However, the millimeter paper usually is not sufficiently transparent for the details to be clearly seen. The contour also may be traced directly on the back of the transparent square millimeter rule. However, the rule easily becomes scratched by repeated tracing and this interferes with later measurements.

Karlin[28] has measured the area in square millimeters by the use of a planimeter. It is a very accurate method feasible for direct measurement from the film with the aid of a horizontal view box.

Hare *et al.*[22] have introduced a practical modification of the method for quick determination of the approximate sellar size. They have traced the most often occurring sizes and shapes on a millimeter squared rule which they have called a "sellameter." One selects the tracing which is nearest in size and shape to the sella in question. When greater accuracy is desirable —*e.g.*, in statistical studies, or in following the change in size in individual cases—one must correct for difference in the standard tracing and the measured sella. In the time required for choosing the nearest standard and correcting for difference, one may easily and more exactly

measure the entire sella. On the commercial sellameter the contours are very thick; the middle of the thick lines should be used to accept the numbers assigned to these tracings.

In determining the sellar area, only two dimensions are considered. In previous reports[14,16,18] I made use of a nucho-frontal projection, which demonstrated the third dimension. (In some respects its aim is similar to the Towne view with which I became acquainted later.) The practical value of the measurement of the roentgenological width is limited. In the lateral view, the target-to-sella and sella-to-film distances are nearly constant in adults. In the nucho-frontal, and even more so in the anteroposterior oblique view, these distance relationships depend to a great extent on the shape of the skull. Therefore, the roentgenological enlargement of the width on these views is not uniform. Cardillo and Bossi[6] recommend determination of the greatest width of the sellar floor by laminagraphy and the authors multiply the surface area, measured by the described method, with this width to obtain the capacity of the sella turcica. The selection of this width is in accordance with the recommendation of Hrdlička.[25] It conforms more nearly to the real width of the pituitary gland than does that of the tuberculum or dorsum sellae. Namiki *et al.*[37] have found on dried skulls that there is a parallelism between surface area and capacity of the sella. Their finding conforms to the practical experiences which justify the usefulness of the sellar surface area.

The *technical factors* mentioned in the paper of 1925[14] are antiquated. A 50 cm. target-film distance, heavy grain glass plates and intensifying screens were used at that time. The differentiation of the three dorsum contours, therefore, was not possible. The use of a target distance of 70 cm. brought about an increase in the size of the sellar area of 12 per cent because of the added use of the Bucky grid. The distance of 36 inches (92 cm.) now generally used eliminates this 12 per cent increase by enlargement so that the enlargement becomes again almost the same as it was in 1925. Kovacs,[31] among others, revised my data using a 70 cm. target distance with Bucky grid. Recently, Mossberg,[36] in an extensive study, furnished additional data using a target distance of 60–70 cm. These results conform generally to those of the original report.[14] However, my previous data of the normal variation should be revised because of changes in technique since that time and because the measurements then were based on a more homogeneous white European racial group. The establishment of norms for the more mixed American population appears necessary and appropriate.

MATERIAL

The present study to establish the normal variation of the size of the sella turcica in various age groups was made on material from the University of Illinois Hospitals. Roentgenograms with obvious gross pathology, with unknown age, and those unsuitable for measurements for technical reasons were excluded. The remaining cases were unselected and include cases with clinical pathology, but undetected roentgenologically. The exact racial distribution is unknown, but approximately 20 per cent of the patients are colored, which is insufficient for racial comparison. Pruett[38] found the modulus of the diameters of colored sellae larger than that of white sellae. The broader concept of the normal and more heterogeneous racial mixture can lead to a somewhat wider range of normal limits. The films were made with a distance of 36 inches, a Bucky grid, and a film-table distance of 5.6 cm.

RESULTS

The data obtained for normal sellar size in various age groups of both sexes are shown in Tables I and II and in the graphs (Fig. 1, 2 and 3). Since one cannot consider as normal everything which occurs in a supposedly normal individual, statistical data must be employed, if possible, to determine the limits of normal. The values of $M \pm 2\sigma$ can be regarded as normal limits, $M \pm \sigma$ as middle sizes. The values between $M \pm \sigma$ and $M \pm 2\sigma$ belong to the borderline zones. The values outside of $M \pm 2\sigma$ are extreme random cases. Statistical methods could be employed only for adults. The number of children included in most groups was not sufficient to establish statistical norms. Only the range of variation and the mean were determined. In the material presented the mean for boys was generally greater than that for girls in the ages of three to seventeen years. Over this age female sellae were slightly larger than those of males. The mean (M) for adult males

Table I

NUMBER OF THE MEASURED NORMAL SELLAE AND THE SIZE OF THE SELLAR AREA IN SQUARE MILLIMETERS IN THE DIFFERENT AGES AND SEXES (VARIATION AND MEAN)

Age	Male			Female			Total		
	N	Range	Mean	N	Range	Mean	N	Range	Mean
– 4 wk.	4	11– 16	14.5	4	10– 19	13.5	8	10– 19	14.0
2– 6 mo.	22	13– 36	19.7	12	11– 28	18.7	34	11– 36	19.4
7–12 mo.	14	17– 38	26.0	13	18– 38	28.5	27	17– 38	27.2
13–18 mo.	15	20– 42	32.3	15	21– 46	33.1	30	20– 46	32.7
19–30 mo.	19	28– 54	38.8	14	27– 54	40.6	33	27– 54	39.6
3– 5 yr.	40	30– 69	48.0	27	29– 69	46.0	67	29– 69	47.2
6– 8 yr.	33	37– 79	58.9	27	37– 72	51.3	60	37– 79	55.5
9–11 yr.	31	43– 86	65.0	19	43– 80	64.0	50	43– 86	64.5
12–14 yr.	29	47– 89	71.8	22	46– 98	69.5	51	46– 89	70.7
15–17 yr.	30	46–104	80.6	17	45– 92	78.8	47	45–104	80.0
18–20 yr.	33	54–121	83.2	28	58–113	84.4	61	54–121	83.8
21–50 yr.	244	59–125	86.1	247	58–120	87.2	491	58–125	86.7
51–60 yr.	54	60–118	88.0	46	59–119	87.0	100	59–119	87.5
61– yr.	40	58–118	86.5	30	78–114	90.4	70	58–118	88.6

was 86.1, and for females 87.2 sq. mm. Namiki *et al.*[37] found the mean on roentgenograms of 83 dried skulls, taken at 100 cm. target distance, as 82 sq. mm. For practical purposes, the values of 58 and 120 sq. mm. can be regarded as the limits of normal sellar area in adults, 70 to 105 sq. mm. representing the middle sizes. The total number of adult cases in the age groups above fifty years was insufficient for comparison with adults below fifty. However, one gains the impression that there is a moderate tendency to larger sellae over fifty years of age.

An interesting finding is that, contrary to several authors, including the writer, the mean of the adult female sellae over eighteen years of age is slightly larger than that of adult males. This fact was established also by Mossberg.[36] Hrdlička[25] found on a limited number of dried skulls that the female sellae are smaller in whites and larger

Table II

STATISTICAL EVALUATION OF ADULT MALE AND FEMALE SELLAE

Age years	N	Median	Range	σ		$M \pm 2\sigma$		$M \pm \sigma$	
				–	+		Per cent of cases		Per cent of cases
MALES									
21–50	244	86	59–125	15.2	15.4	55.9–117.2	97.9	71.1–101.7	67.9
51–60	54	89	60–118	13.0	15.8	69.8–121.4	95.5	76.8–105.6	63.6
61–	40	89	58–118	15.8	18.9	54.9–124.4	100.0	70.7–105.4	63.9
FEMALES									
21–50	247	86	58–120	15.0	15.8	57.2–118.9	98.7	72.3–103.1	70.3
51–60	46	87	59–119	12.6	14.7	62.2–116.9	94.7	74.9–102.2	68.4
61–	30	89	78–114	11.8	13.0	68.4–118.0	100.0	80.2–105.0	73.9

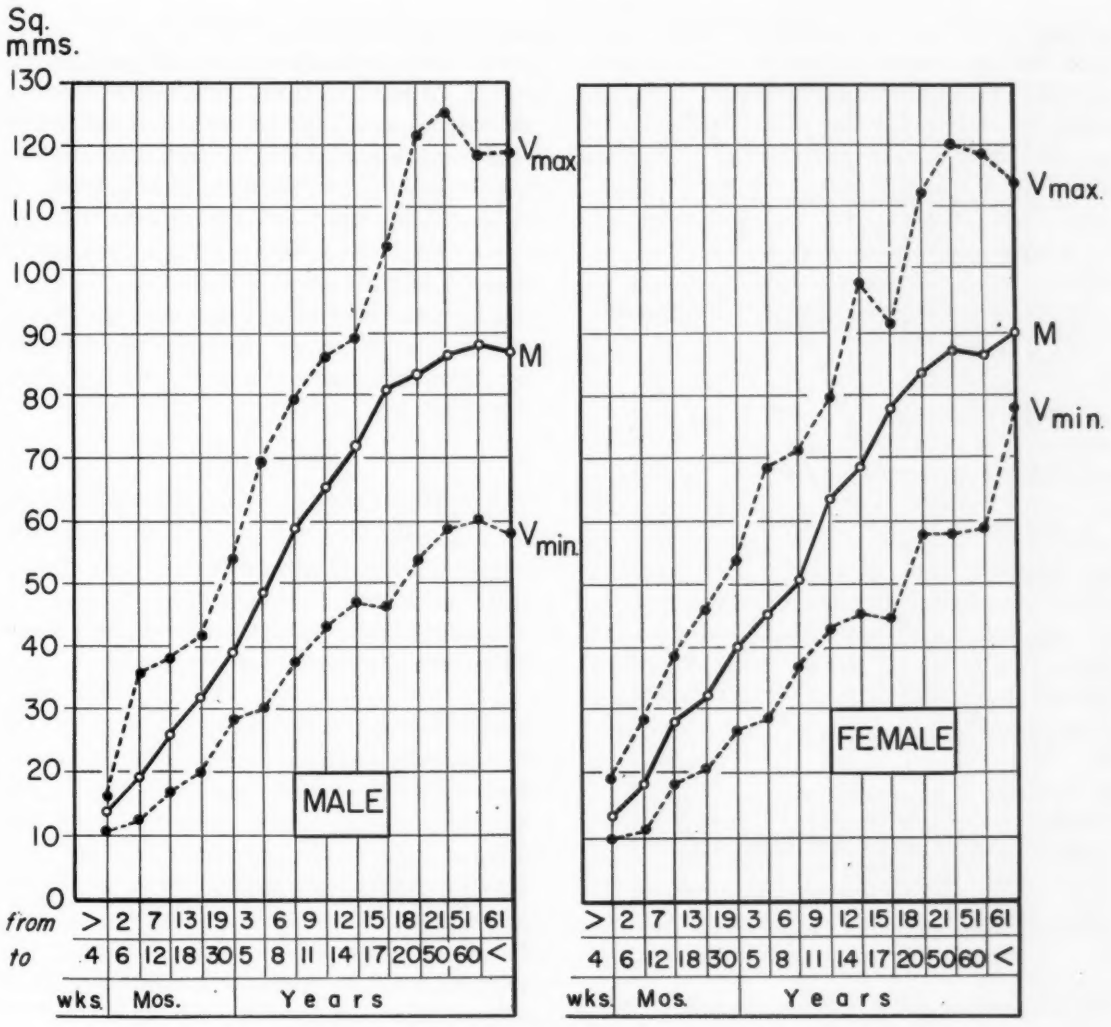

Fig. 1 and 2. Development of the sellar size (mean and range in different ages).
Fig. 1. Male. Fig. 2. Female.

in colored skulls as compared to the male sellae. On the contrary, Pruett[38] found slightly higher values for the modulus of the three sellar diameters of white females, and lower values for colored females, than for male sellae; further, that the female sellae were relatively larger proportionally to the cranial circumference than were the male. It is also possible that some enlargement of the sellae may occur in connection with pituitary hypertrophy in young multiparous females. Klöppner[30] found, for instance, that the sellar area of 10 nulliparous females varied from 57 to 104 sq. mm., and in 10 multiparous females varied from 55 to 131 sq. mm. If the majority of the females are multiparous, it may influence the results. This question requires further investigation.

The question often arises as to the *relationship of the size of the skull to that of the sella*. The data obtained by various authors are not in agreement. Kadanoff[27] reports no significant correlation. On the contrary, Pruett[38] found a definite correlation between sellar size and circumference of the skull. The literature contains references concerning a relationship of length of the skull and sellar size. Table III gives the sellar area in square millimeters as well as

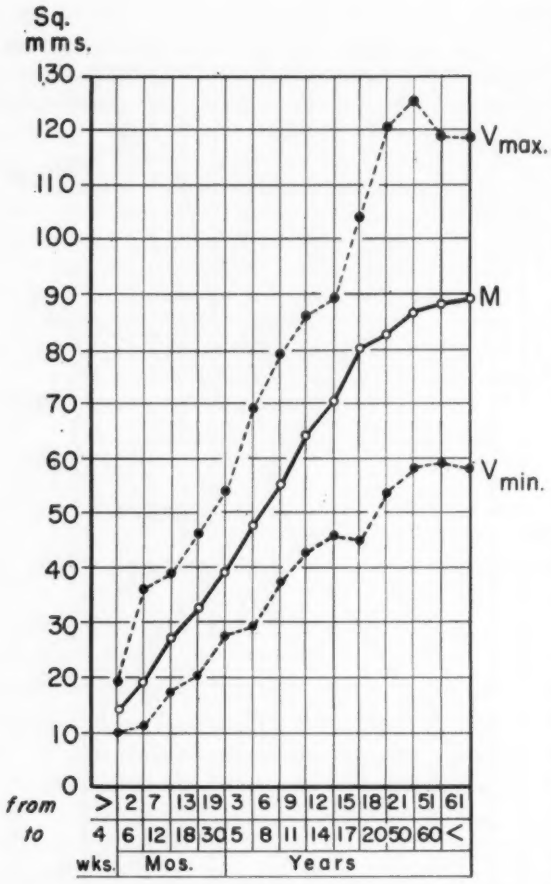

Fig. 3. Development of the sellar size (mean and range in different ages of both sexes).

skull length in a group of adult males. There is no constant and definite correlation between the two measurements. In every group of sellar size one finds smaller and larger skull lengths and only in the borderline groups was a slight parallelism found. When measured sellae were smaller than 70 sq. mm., the arithmetic mean of the skull length was about 2 mm. shorter than the length of the groups with middle-sized sellae. If the sellae measured over 100 sq. mm., this mean was about 2 mm. greater than in middle-sized sellae.

Table III

Relation of sellar size to the length of skulls of adult males

Sellar Size (sq. mm.)	Number of Cases	Length of Skull	
		Range (mm.)	Mean (mm.)
50– 59	5	201–215	209.9
60 –69	37	191–225	210.1
70– 79	70	178–231	211.7
80– 89	71	196–232	211.8
90– 99	72	189–240	211.0
100–109	41	198–232	213.5
110–119	21	205–230	213.8

The establishment of norms of sellar size is necessary in order to apply the method for theoretical investigations and clinical examinations.

Discussion

The measurement is aimed mainly[17] to facilitate the description and the morphological differentiation of normal and abnormal sizes of the sella turcica.

It is evident that for *academic* investigations measurements are necessary.

For *clinical* purposes, the subjective estimation by eye is sufficient if the sella is of average shape and size, or if the deviation is conspicuous. However, the visual differentiation may be very delusive in special cases, *e.g.*, when the size is close to the borderline, or when the sella profile is obscured by several contours or confusing clinoid bridges. In such dubious cases the measurement is more reliable. It is also very valuable and illustrative when one can compare the same sella in different periods, by observing its growth, progress of pituitary pathology, or in describing the degree of deviation from normal size. Of course, a lesser trained examiner will resort to the support of measurements more often than the experienced skull diagnostician.

The diagnostic practical significance of sellar size and its measurement should not be over- or underestimated. As every medical sign, also the sellar size has various limitations in *clinical* use. There is a certain degree of parallelism between the growth of cavitary bone formations and their content, accordingly also between pituitary fossa and gland, particularly during undisturbed juvenile development. But the parallelism is not constant. The discrep-

ancy is influenced by various factors. The sella cavity is not enclosed entirely by bony walls. A decrease in size of the hypophysis will not be followed by decrease in size of the bony bed. Physiological events in the complex endocrine system, *e.g.*, atrophy due to aging and also other processes, may decrease the hypophyseal size, without change of the sella. The sella may be enlarged, without exceeding the normal limits, due to the wide normal range. Additionally, the size of a gland is not always proportional to its function. The qualitative structure of the same sized gland may be different. Tumor tissue may also replace a part of the gland, without enlarging it. All these limitations do not detract from the diagnostic importance of the measurements, as every medical sign should be evaluated within the framework of the other clinical and roentgenological findings in a given particular case.

Knowledge of the limitations facilitates the understanding and evaluation of the discrepancies that one finds occasionally, such as "abnormal" values without evidence of disease and conversely "normal" values with obvious pathology. However, a sella with a size outside of normal limits must be considered "abnormal." In the case of a large sella described by Benjamin[1] there was no evidence of disease for years; ultimately, fulminating cerebral symptoms led to death, and autopsy revealed a large pituitary tumor. Routine autopsy of all pituitary glands by Costello[8] showed in 22.5 per cent adenomas of various types and sizes without clinical symptoms. All cases with borderline or larger sellar size must be followed with the possibility in mind that symptoms may appear at a later date similar to an asymptomatic struma. Yet such cases occur only rarely. An "abnormal" sellar size usually has definite clinical significance.

A sellar size below the "normal" limits is usually the result of a pituitary hypoplasia. It can be a sign of a present or of a previous childhood endocrine disturbance.

Sellae above the "normal" limits of size may be of (1) intrasellar, or (2) extrasellar origin. (1) Intrasellar origin: (a) the idiopathic, constitutional type; (b) hyperplasia, such as in polyglandular endocrine diseases; (c) pituitary tumors; however, some pituitary adenomas, particularly the basophilic tumors, cause very little, if any, enlargement. (2) Extrasellar origin: (a) space-occupying suprasellar or parasellar lesions invading the sellar cavity directly; (b) any space-occupying intracranial lesion giving rise to increased intracranial pressure; frequently a secondary internal hydrocephalus causes dilatation of the third ventricle and its bulging into the sellar cavity. Increased intracranial pressure caused by cerebral neoplasms, without hydrocephalus, occasionally produces changes of the sella.[21] The differentiation of the various types of sellar enlargements can be made frequently from the other roentgenological findings. In other instances, the additional help of the clinical data may be required.

A review of the pertinent literature reveals that this method of measurement of sellar size was applied for clinical diagnostic examinations as well as for developmental and constitutional investigations.

SUMMARY

1. The technical details of a method, originally introduced by the author, are described for the roentgenographic measurement of sellar area in median plane projection. The related literature is also considered.

2. Norms of sellar size are established and reported for various age groups of both sexes, obtained on the racially mixed material of the University of Illinois Hospitals.

3. The concepts of "normal" and "abnormal" size of the sella turcica are discussed and the clinical significance of smaller or larger sellar sizes briefly summarized.

4. The method is in use for constitutional and developmental investigations and for clinical diagnostic examinations.

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THE ROENTGENOLOGICAL AND PATHOLOGICAL ASPECTS OF TUBERCULOSIS OF THE SKULL

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TUBERCULOSIS of the bones of the skull is rare. In 1933 Straus[5] found only 220 cases in the world literature. The records of the New England Peabody Home for Crippled Children revealed only 2 cases, or 0.5 per cent. However, in China, Meng and Wu[3] reported more than 70 cases in fourteen years, and an authority[4] on skeletal tuberculosis made this remark: "Tuberculosis is, of course prevalent in China and this frequency is not surprising." But pulmonary tuberculosis is also prevalent in the Philippines with annual mortality of over 35,000 for a population of about 20 million. There are also numerous cases of skeletal tuberculosis. At the National Orthopedic Hospital at Mandaluyong, Rizal, Philippine Islands, in the outpatient department alone one can see as many as 5 or 6 cases of skeletal tuberculosis in one morning. Yet in spite of the abundant material in this hospital, there were only 3 cases of tuberculosis of the skull during the last five years, or 0.4 per cent.

This great discrepancy, of the incidence of skull tuberculosis as seen in two different clinics, in China and in the Philippines respectively, two Oriental countries, whose inhabitants are practically the same as far as modes of life and foods are concerned and in both of which pulmonary tuberculosis is prevalent, gives rise to speculation as to what causes it. Are there any racial predisposing chemicobiologic factors in this type of skeletal tuberculosis or are the Filipino physicians not skull-tuberculosis conscious, which leads to deficient case findings? No opinion can be given on the first question as there is no study being made on the subject at present. As to the second part of the question, in my personal opinion, failure to perform routine roentgenological examination of the skull, especially in the presence of skeletal tuberculous focus or foci elsewhere in the body, is probably a factor to be considered in the nondetection of many cases of skull tuberculosis. The present practice in this hospital not to roentgenograph the skull unless there are symptoms referable to the head, even in spite of multiple foci elsewhere in the body, is conducive to missing many of these cases. Many investigators have revealed in their studies that a lesion in the flat bones of the skull per se is very rare and that a high percentage (Meng and Wu, 95 per cent; Sanchis-Olmos, 100 per cent) of these cases are accompanied by lesions in other bones or parts of the body. A similar impression is gained from the 3 cases herein presented. One should not wait for clinical symptoms to develop before a routine roentgen examination is ordered as many of these cases appear insidiously, nor is there any localized manifestation in the skull in the early stages. In the late stages, especially when perforation of the inner table takes place, symptoms may be manifest due to meningeal irritation or localized cerebral pressure. This fact is well illustrated in Case 1, where the first focus of infection was in the distal end of the first right metatarsal and, probably later, in the left os calcis. While the patient was under observation, she developed an "epileptic-like" attack according to the description of the nurse on duty. Had not this symptom developed, roentgenograms of the skull would not have been taken and this case would certainly have been missed because there were not at first any symptoms referable to the skull to warrant routine roentgenologic examination.

PATHOLOGY

According to the autopsy studies of Hübschmann and Randerath, the skeletal seedings after hematogeneous dissemination from a primary focus of infection are very great in number and affect almost all the bones. But there are a few of these skeletal impregnations that develop to a stage of clinical manifestation in certain cases but not in others, and that certain type of lesion has a predilection or preference for certain bones and joints. As to what is the real cause is not definitely determined and there are several theories offered.

Kramer and Wiese[2] think that the predilection of skeletal tuberculosis for certain areas is influenced by the greater circulatory hazard of the infected zones. Ely, Cowan and Gonzalez-Aguilar think that zones rich in lymphoid elements are the parts infected. Gonzalez-Aguilar refutes the theory of Kramer and Wiese that tuberculosis of the flat bones of the skull is rare,

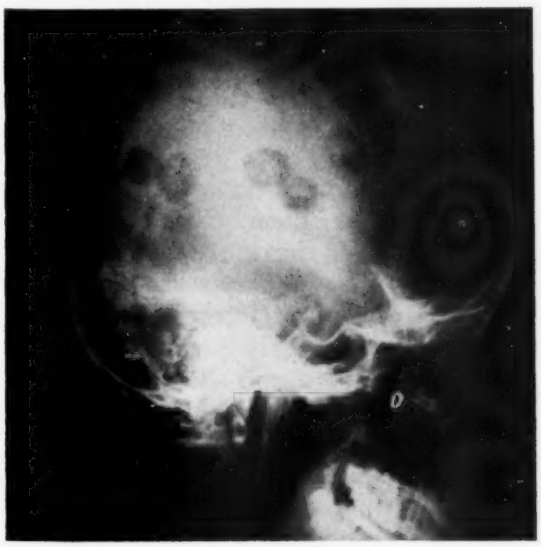

Fig. 1. Case 1. P.T., female, Filipino, aged fifteen, complained of pain and swelling on the dorsum of the right foot and later in the right ankle. Roentgenogram showed tuberculous osteitis of the right first metatarsal and right os calcis. There was also left active pulmonary tuberculosis and pleuritis. The skull shows multiple caseous foci, some with sequestrum formation, while others are bone caverns.

Fig. 2. Case 1. Roentgen-ray check-up of the skull of P.T. after seven months, showing marked recalcification of lesions. Improvement was also noted in other foci of the body.

because these bones are too poor in lymphoid elements in spite of their great vascularity.

Personally, I am more in favor of the latter theory because in tuberculosis of long bones, like the femur, a tuberculous focus in the epiphysis or metaphysis is frequent, whereas in the diaphysis it is rare. The question then arises as to why is this so in spite of the apparent abundance of bone marrow in the shaft. I think this can be explained histologically in this way. The bone marrow is composed of yellow and red marrow. The yellow marrow consists mostly of fat and very little true marrow tissue. The red marrow has very little fat but is rich in vascular lymphoid tissue. The embryonic medulla of all bones contains fetal red marrow, but later in life, a large portion of the medulla of the shaft of the long bones in man is converted to yellow marrow. The red marrow, however, persists in the epiphysis and cancellous bone of the metaphysis, hence the frequency of osseous foci in the epiphysis or metaphysis, and the rarity in the shaft or diaphysis.

The lesion begins from the diploe and extends either externally or internally or both, in the form of cone-like destruction. When both tables are involved, an hourglass deformity is produced. Some investigators believe that this cone-like form of osteolysis is quite characteristic of skull

tuberculosis and can be used to differentiate the lesion from syphilis of the skull.

The frontal and parietal bones are the most commonly affected and the caseous type is the most frequently encountered. The cases presented in this report are of the caseous type. The focus of infection in the skull may be single or multiple. The external tables were generally destroyed first, as the destructive process appeared to be more advanced, because of being caseous, while the inner tables were later involved as they showed incomplete destruction as manifested by the presence of sequestra formation surrounded by rings of osteolysis. In case 1, where the lesions were multiple, the impression gained during the biopsy was that there seemed to be intercommunicating channels filled with necrotic and granulation tissues between these areas of necrosis. If this observation were correct then it gives rise to the question as to whether these multiple foci of infection in the skull are mere direct extensions from a single focus or activation of the numerous skeletal seedings by an exudative caseous type of infection causing wide spread of the lesions in the skull or both. Meng and Wu believe that sudden appearance of multiple lesions is indicative of failure of the general resistance of the patient; however, this is not my experience in the 3 cases herein reported, which are too few for definite conclusions to be drawn.

The granular type of infection is rare. So far there was only one case that was roentgenologically and clinically suspicious but it was not included in this report, because no biopsy could be done.

ROENTGEN FINDINGS

Early roentgen findings in skeletal tuberculosis are few and not specific. The reason for this is that the structure of the bony tissue is not ideal for the detection of small lesions. Sometimes lesions that are macroscopically visible are still not demonstrable in the roentgenogram. This is in contrast to pulmonary tuberculosis in which minimal lesions are easily detected on the film, because the air content of the alveoli gives a good contrast or background for the minimal densities cast by the infiltration. This early or meager roentgen finding gives rise to the so-called "negative roentgen phase" of skeletal tuberculosis. For the proper detection of an early osseous focus, it must be of sufficient size and demonstrable in the routine or conventional roentgen-ray positions. In view of this fact, early roentgen findings do not help much in diagnosis without other supplementary examinations.

The first roentgen finding in active tuberculosis of bones or joints is osteoporosis or decalcification, which is a nonspecific chemicobiologic phenomenon. The extent and degree of decalcification depends upon the number of foci and type of lesion. Osteoporosis is better appreciated in tuberculous osteoarthritis in the epiphyseal and metaphyseal portions of the long bones. The exudative type of lesion gives the greatest degree of decalcification. Osteoporosis is an index of activity of the skeletal lesion, as recalcification is an index of healing. Sometimes the decalcification is so great that it gives a false impression that the bone has been destroyed.

The roentgenologic findings in the granular type depend upon the evolution of the osseous lesion. In the destructive process of the bone by the granulation tissue, there is a localized area of rarefaction or subnormal density with sharply defined borders. Roentgenologically, this shadow is not different from other osteolytic processes produced by other infections, fibrous dysplasia, tumors, etc. If the osseous focus is active, it increases in size, as shown by serial roentgenograms. If the granular lesion undergoes a caseous process, a bone cavern is produced. If the focus becomes quiescent, a dense ring is formed, indicative of fibrous tissue formation, which has a tendency to displace the granulation tissue. Generally a residual focus is seen in the roentgenogram after healing, the density of which approaches that of normal, except

in children where restitutio ad integrum is still possible.

In the caseous type where the necrosis of the bone is rapid due to the disturbance of blood supply, the caseous focus becomes dense. This density in the beginning is not easily detectable roentgenographically until the perifocal decalcification has attained a certain degree of intensity, in which case the roentgen appearance then is that of an osteolytic ring surrounding a dense area—the caseous focus. The density increases as the deficiency of blood supply becomes more complete on the theory that ischemia increases the precipitation of calcium salts, just as hyperemia produces decalcification.

The caseous focus may be destroyed by nearby granulation tissue or eliminated through fistulization, and thus a bone cavern is formed. Roentgenographically, a bone cavern produced by a caseous type is the same as that of a granular or mixed type of lesion. Differentiation can only be established through serial roentgenograms showing the evolution of the lesion. During the process of healing, there is a diminution of the area of rarefaction with evidence of recalcification.

DIAGNOSIS

The criterion for the diagnosis of skeletal tuberculosis, like that of pulmonary tuberculosis, is the demonstration of tubercle bacilli. With the present routine methods of bacteriological examination, these bacilli are not easily demonstrable without much loss of time, so that other supplementary methods of examination must be utilized before a working etiologic diagnosis is established. For this reason, a knowledge of the values and limitations of these special examinations is timely.

Roentgenology in the Diagnosis of Skeletal Tuberculosis. Roentgenology as a special method of examination in the diagnosis of skeletal tuberculosis furnishes a rapid method of determining the location and extent of the lesion. However, it has the disadvantage in not detecting minimal or early lesions and its probable etiologic nature without considering other supportive data. From a roentgenologic standpoint, the fundamental question to be considered is whether the abnormal features in the roentgenograms are associated with or caused by tuberculous infection. This cannot be unequivocably answered from the study of the roentgenogram alone, as the shadows produced by tuberculosis are not sufficiently characteristic, although serial roentgenograms may be most helpful. And it is also not the responsibility of the roentgenologist to give an exact etiologic diagnosis.

Tuberculin Test. A positive tuberculin reaction means that an individual has, at some time, harbored tubercle bacilli in his body, but it does not necessarily mean that active clinical tuberculosis is present or has ever existed. In an adult, a positive reaction may be the residual of a spontaneous healed tuberculosis contracted during childhood.

Bacteriologic Examination. In the bacteriological examination, demonstration of tubercle bacilli in the smear, histopathological section, culture and guinea pig inoculations are the methods used. However, failure to demonstrate the tubercle bacilli with these methods in suspected cases does not rule out its absence.

Histopathologic Examination. In biopsy examination a good specimen is essential. Oftentimes too necrotic a tissue or an unsatisfactory specimen is sent to the pathologist which of course gives very little information and naturally the pathologist will give a noncommittal report such as chronic infection. A good biopsy specimen must not only include the pathologic portion but also part of the normal tissue so that the transitional changes can be well appreciated and at the same time can be utilized for bacteriological studies. Cooperation, therefore, is necessary between clinician and pathologist in order to obtain a good biopsy specimen.

The clinician, radiologist and pathologist must be familiar with the evolution and the different types of tuberculous lesions.

Knowledge of these conditions is important as histopathological findings vary with these factors.

Students from different schools are more or less unanimous as to the fundamental pathologic phenomena that take place in skeletal tuberculosis. Gonzalez-Aguilar believes that three phenomena exist: exudative, productive or granular, and caseation. These phenomena are always present and what consitutes the different pathological types is the preponderance of one of these phenomena.

In the initial exudative lesion of tuberculous osteitis the signs of vascular response are generally manifested by different reactions such as cellular, toxic, and chemical. The histopathological picture of cellular reaction is the presence of premature, mature polymorphonuclears and large mononuclears around a blood vessel. The toxic reaction is generally accompanied by areas of bone necrosis of varying degrees of severity. The chemical reaction is manifested by a nonspecific chemicobiologic phenomenon; osteoporosis or decalcification which can be demonstrated in the roentgenogram. The clinical manifestation is early abscess formation, since there can be nothing else to represent this collection of histologic elements or leukocytes.

The exudative type of lesion is mostly seen in tuberculosis of the spine, where paravertebral abscesses are oftentimes formed, but none, so far as I know, has been reported in the skull.

In the productive or granular type, there is new tissue formation in the form of typical granulation tissue filled with tubercles. It is this granulation tissue that destroys the bone. The histopathological findings of the typical granular lesion consist of areas of lymphocytes, giant cells, and fibroblasts. The nuclei of the giant cells may either be arranged peripherally or packed across the center. At times these areas of lymphocytic infiltration with giant cells are surrounded by concentric fibroblasts forming whorls or tubercles. These tubercles are quite characteristic of the granular type of tuberculous osteitis. The blood vessels are generally congested and numerous.

In the caseous type, the infected zone of the bone is deprived of circulation and central necrosis is produced. The necrosis produced in this type is primary in contrast to that of the exudative type which is secondary.

Histopathological examinations of granulation tissue may be negative, while others are positive for tubercles, the reason for this is that granulation tissue of granular osteitis is specific, whereas granulation tissue of the exudative or caseous types is generally nonspecific, except in mixed types. This is probably one of the facts which gives rise to confusion in the minds of some clinicians when they order for a histopathological examination of some granulation tissues for further verification of a case that is clinically and roentgenologically that of skeletal tuberculosis, because the report of the pathologist is nonspecific chronic infection. In granular tuberculous osteitis the main function of the granulation tissue is destructive, while in the other two types it is mostly that of repair.

This concept of specific or nonspecific reaction may also be applied in the examination of exudates. For example, in hydrarthrosis of a knee joint with a tuberculous osteitic focus, repeated aspiration may prove negative by culture or animal inoculations, and yet the case is clinically and roentgenologically tuberculosis. This can be explained by the fact that the focal osteitis produces a nonspecific perifocal reaction in the form of hydrarthrosis. But when the focus is located in that portion of the epiphysis close to the synovial membrane or in the synovial membrane proper, it will produce tuberculous synovitis and later osteoarthritis. The perifocal reaction in this case is generally specific and the chances of demonstrating the tubercle bacilli are great. A similar condition takes place in pulmonary tuberculosis. Tuberculous parenchymal lesions per se may give rise to nonspecific pleuritis, but with the

involvement of the pleura, the pleuritis becomes specific.

The equilibrium between bacterial virulence and host resistance is another factor which may change the histopathological picture, depending upon the evolution of the lesion. A granular or an exudative type may become granular or exudative caseous or fibroproductive. The use of antibiotics may also influence the histopathological findings, as shown by the studies of one of the members of the staff of the National Orthopedic Hospital by performing biopsy examinations before and after a series of streptomycin therapy in skeletal tuberculosis.

Because of the various factors that may affect the histopathological pattern of skeletal tuberculosis due to different tissue reactions, the result of the biopsy examination is only considered presumptive, except in certain cases where there is typical tuberculous tissue formation and final etiologic diagnosis rests on isolating and identifying the tubercle bacillus. It must be admitted that diagnosis of skeletal tuberculosis, especially in atypical cases, is at times very difficult, but a thorough follow-up examination and observation may yield sufficient evidence to establish an etiological diagnosis of tuberculosis beyond a reasonable doubt. If tubercle bacilli cannot be readily demonstrated and a working diagnosis is necessary for the management of the case, the clinical, roentgenological and histopathological findings must be correlated and carefully evaluated by the clinician. The activity of the osseous focus must also be determined to as great an extent as possible as this is also necessary in the management or treatment of the case.

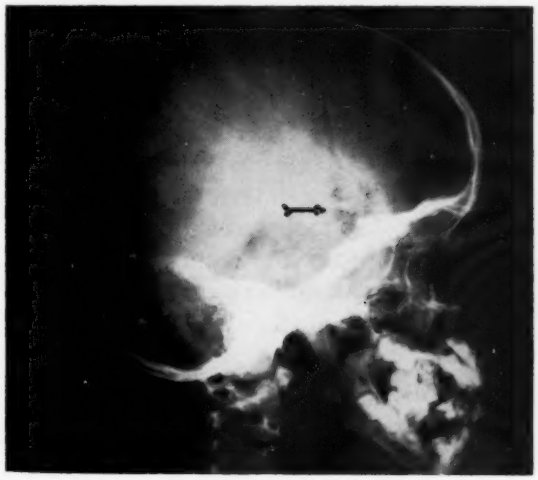

Fig. 3. Case II. R.B., male, Filipino, aged three years, with the chief complaint of headache and a small mass in the right frontoparietal region. The roentgenogram shows tuberculous osteitis, caseous type, with sequestrum formation. Later the patient showed loss of vision in one eye. Further roentgenographic and histopathologic studies showed a destructive process of the optic foramen of the affected eye, of tuberculous nature also.

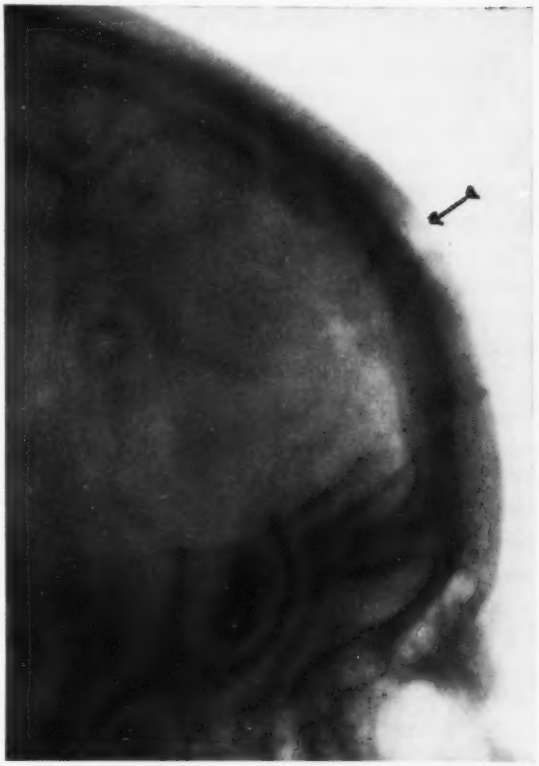

Fig. 4. Case III. J.C., male, Filipino, aged thirteen, with the chief complaint of a lump on the dorsal spine. Roentgenograms showed tuberculosis of D-9 and D-10 with suspicious paravertebral abscess. A roentgenogram of the skull was made because of a small mass on the forehead which showed a destructive process about 0.5 cm. in diameter of the outer table of the frontal bone, extending into the diploe but without involving the inner table. This case illustrates an early lesion of the skull.

SUMMARY

Three cases of tuberculosis of the skull of the caseous type are reported. The apparently low incidence of skull tuberculosis in this report is probably because the hospital staff is not skull-tuberculosis conscious which led to deficient case findings. The gross pathology is faithfully portrayed on the roentgenogram except in severe decalcification when it might give the false impression of a destructive process. Some confusion in histopathologic diagnosis is explained on the basis of modern concepts of pathology of skeletal tuberculosis. The criterion for the diagnosis is the isolation and identification of the tubercle bacillus, although to a certain extent the demonstration of typical tuberculous tissue formation in the histopathological section may be sufficient. The results of other supplementary methods of examination are considered presumptive and a brief review of their value and limitations is hereby given. In establishing a working diagnosis in the absence of a positive evidence of the disease, the clinical, roentgenological and histopathological findings must be carefully evaluated and correlated.

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Vol. 72, No. 5

PULMONARY HISTOPLASMOSIS

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PROBABLY not since White and Hill's[6] report on pulmonary calcification in 1950, has there been a complete report on this subject until Furcolow and Grayston[2] reported the occurrence of histoplasmosis in epidemics.

White and Hill believed the etiology of this calcification was an enigma. Many investigators described the calcification to be healed miliary tuberculosis. A contribution to a better understanding of the etiologic problems of pulmonary calcification was made by the observation that in certain regions many individuals with such calcification did not react to tuberculin.

Christie and Peterson,[1] in 1945, demonstrated a relationship between nontuberculous pulmonary calcification and skin sensitivity to histoplasma. A filtrate of a culture of histoplasma was demonstrated.[5]

Several writers have commented on the geographic distribution of histoplasma infection. Long and Stearns[3] found the greater prevalence of pulmonary calcification in the Eastern Central region. It is now believed that more cases were found in this location simply because Ray Brook State Tuberculosis Hospital and others were on the lookout for the infection.

Sources of infection were vague at first, but later found to be due to dust exposure. The dust of threshing machines and the dust about the habitat of pigeons and domestic fowl were found to contain the organisms.

Furcolow and Grayston[2] mention the fact that histoplasmosis as occurring in epidemics has received very little attention. They discuss the twelve epidemics reported and outline some of their characteristics. It is noted that epidemics of histoplasmosis consist of cases with a disseminated pneumonitis which tend to heal by eventual calcification. The criteria used in establishing an epidemic are as follows:

1. Isolation of *Histoplasma capsulatum* from the soil at the point source of the epidemic.
2. The presence of positive serological tests for histoplasmosis.
3. The presence of positive histoplasmin skin tests.
4. The development of miliary calcification reported.

The reported epidemics were widespread. In 1938, an epidemic in Plattsburg, New York, was described as "acute miliary pneumonitis."

An epidemic at Camp Gruber, Oklahoma, in 1944, was reported as "an unusual pulmonary disease."

An epidemic reported as "cane sickness," occurred near Fareman, Arkansas, in 1947.

An epidemic occurred in Cincinnati, Ohio, in 1947, and was reported as "pneumonia of unknown etiology."

"An unusual type of pulmonary disease involving six members of a family" was reported in Detroit Lakes, Minnesota, in January, 1948.

An epidemic called "angleworm pneumonitis," occurred in Madison, Wisconsin, in 1948.

An epidemic was reported by Loosli, Grayston, Alexander and Tanzi[4] as "pulmonary histoplasmosis in a farm family."

At Camp Crowder, Missouri, an epidemic of pneumonitis was reported in 1943 as "atypical pneumonia."

ROENTGENOLOGIC ASPECTS

Due to the marked similarity of the roentgenographic findings, definite criteria are laid down. In the acute infection, the lesions are relatively large, irregular, discrete patches of consolidation. The lesions are usually distributed throughout both lungs (Fig. 1). There may be a mild infection, however, where the infiltrate is small or patchy in character. Lymph node

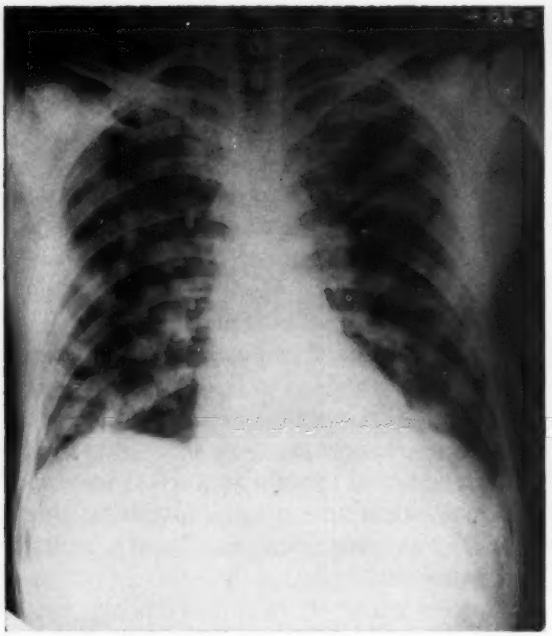

FIG. 1. Roentgenogram showing acute pulmonary lesions.

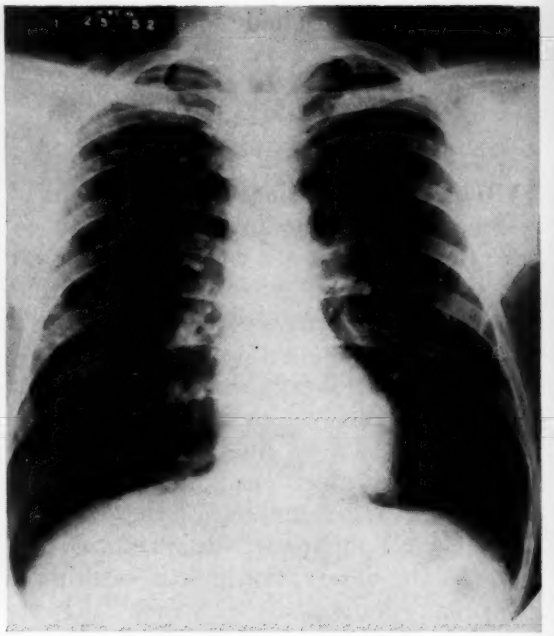

FIG. 2. Roentgenogram showing the usual calcification seen in healed histoplasmosis.

enlargement is usually present.

The lesions tend to clear in a varying period of months, and most of them persist to heal by fibrosis or calcification. These small calcific densities vary from 0.5 mm. to 3 mm. in diameter. Section of the lungs shows these small densities throughout the lung parenchyma with no particular relation to anatomic structures. These lesions will vary in degree of fibrosis, calcification and necrosis. After these lesions heal, there is no inflammatory reaction, either acute or chronic, immediately adjacent to these nodules.

Only rarely are relapses reported. Patients showing these calcified lesions in the lungs are almost invariably sensitive to histoplasmin skin tests.

CASE REPORT

M.G. (History No. C8233), a thirty-nine year old white carpenter came into the hospital May 1, 1947, with a history of working with six other carpenters in taking down a colored church belfry. This belfry had been used for years by pigeons and there was an estimated half ton of pigeon manure deposited on the floor. There were also a few young squabs, and several (6 or 8) dead pigeons were found in the loft. The patient ate 2 or 3 of these young pigeons and two weeks later, on May 13, he noted a mild general malaise and some fever, but continued to work until two weeks later when he had severe chills followed by high fever and a rash over the antecubital spaces. He had a severe inspiratory chest pain throughout his lungs. His cough was productive of about 30 cc. of black thick sputum. The diagnosis of "flu" was made by his local physician and he was started on sulfonamides. Slight blood was noted in the sputum from time to time. Blood was observed by his family physician in his urine on several occasions. Albumin was also present. Penicillin was started May 24 and continued for four days. He received about 1,000,000 units during this time. The patient was delirious on several occasions during the four days before admission.

Upon admission to Duke Hospital, temperature was 38.8°C., pulse 88, respiration 22, and blood pressure 120/68. Physical examination showed numerous fine to medium moist rales over both lungs, with the rales more numerous in the axillae and at the bases. In addition, there were scattered sonorous and sibilant rhonchi which varied in location and intensity. The heart was not enlarged and there were no murmurs. The liver was felt four fingerbreadths be-

low the right costal margin and the spleen one to two fingerbreadths below the left costal margin.

A roentgenogram of the chest showed diffuse, patchy densities varying in diameter from 5 mm. to 2 cm., scattered uniformly from apex to base throughout both lungs. No free fluid was found. Hemoglobin 12.8 gm.; red blood cell count, 4,550,000, white blood cell count, 5,350, with a differential count of 55 per cent polymorphonuclears, 2 per cent stabs, 2 per cent juveniles, 2 per cent eosinophils, 22 per cent large lymphocytes, 1 per cent monocytes, 10 per cent small lymphocytes; 6 per cent abnormal mononuclears were seen in the blood film. Many of the polymorphonuclears had dark staining cytoplasmic granules. Sedimentation rate 42 mm. per hour corrected; hematocrit, 42; spinal fluid showed 4 polymorphonuclears and the Pandy and benzidine tests were negative; spinal fluid pressure; urine, clear amber, specific gravity 1.023, acid reaction, negative for albumin, sugar and acetone; microscopic examination showed an occasional white blood cell, no red blood cells or casts.

The patient was given intravenous fluids and penicillin continued at the level of 25,000 units every three hours. Temperature remained about 104°F. until the morning of May 29 and then dropped to normal and had remained normal up to May 31. He was discharged and has remained well since (Fig. 2).

SUMMARY

This report deals with a case of relatively benign pulmonary disease which presents a typical roentgenological appearance of disseminated pulmonary calcification. The disease seems to have a direct relationship to organic dust, pigeons and certain fowl (White and Hill).

Skin sensitivity is found in a very high percentage of cases of disseminated pulmonary calcification.

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MANIFESTATIONS OF HODGKIN'S DISEASE OF THE GASTROINTESTINAL TRACT*

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USUALLY the first signs of Hodgkin's disease are enlargement of superficial or intrathoracic lymph nodes. Occasionally the first manifestations of the disease will be referable to the gastrointestinal tract. During the last ten years (1942–1952) a diagnosis of Hodgkin's disease was confirmed in 217 patients seen at the Cleveland Clinic. Of these, the first and only manifestations on admission were referable to the stomach in 6 cases, the jejunum in one and the ileocecal region in one. Instances of both Hodgkin's granuloma and Hodgkin's sarcoma were found, but Hodgkin's paragranuloma as described by Jackson and Parker were not encountered.

Schlagenhaufer (1913) is credited with reporting the first case of Hodgkin's disease limited to the gastrointestinal tract, although Pitt (1889) had earlier described involvement of the stomach and duodenum in the course of Hodgkin's disease. We have reviewed the literature since 1913, and have found reports of approximately 200 cases in which the gastrointestinal tract was the principal or only site of involvement detected. Most of these cases have been included in previous reviews of the subject, notably those of Coronini (1926), Hayden and Apfelbach (1927), Singer (1931), Sherman (1938), and Bini and Parvis (1940).

Different criteria have been used by various authors in determining what cases should be considered as primary Hodgkin's disease of the gastrointestinal tract. In our review we have included only those in which the gastrointestinal lesions were clinically predominant or manifest first and in which the lesion occurred as a single focus. It seemed most practical to limit the presentation to the cases in which gastrointestinal symptoms were of clinical prominence not only because the primary site is often difficult to determine, even at autopsy, but because the management of the gastrointestinal problem will seldom be influenced significantly by the presence of history of minor lesions elsewhere. Limitation of the series to those cases with a single gastrointestinal focus makes it possible to correlate more clearly the clinical and roentgenologic findings with the pathologic observations.

The lesions involving the esophagus, stomach, small intestine, and colon will be considered separately.

ESOPHAGEAL LESIONS

Esophageal involvement in Hodgkin's disease is extremely rare. Chioléro (1935) found only 3 instances in the literature, in 2 of which there was associated involvement of cervical lymph nodes; the third had widespread disease. He mentioned also 1 other unreported case, primary in the esophagus, and described another of his own; in both of these, autopsy failed to reveal any lesions elsewhere, even in the local lymph nodes. All of these esophageal lesions resembled carcinoma clinically and roentgenologically. In a series of 174 cases of Hodgkin's granuloma, Jackson and Parker found a lesion in the esophagus only once. The diagnosis of Hodgkin's granuloma had been made in cervical lymph nodes, when dysphagia developed and esophagoscopy showed "a large, freely bleeding and obstructive neoplastic process at the junction of the middle and lower thirds." Biopsy confirmed the diagnosis of Hodgkin's granuloma. Following "appropriate x-ray therapy" no trace of the lesion could be found by roentgenologic examination. Sev-

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eral months later the patient died of unknown causes. No instance of esophageal involvement was found in our series.

GASTRIC LESIONS

Steindl reported the first case of primary gastric Hodgkin's disease in 1924. We have found reviews of 45 additional cases which satisfied the criteria previously outlined. We report an additional 6 cases observed at the Cleveland Clinic in the past decade (1942–1952), making a total of 52.

The stomach is the most frequent site of involvement by isolated gastrointestinal lesions of Hodgkin's disease. The chief symptoms encountered, and their duration, are summarized in Table I.

The epigastric pain simulated that due to peptic ulcer, sometimes even to the extent of being relieved by food or alkali. Sooner or later it usually became constant and severe, although a number of patients experienced only vague distress. Weight loss was usually a prominent feature, many patients losing 20 to 30 pounds within a few months. Gastric carcinoma was therefore a frequent clinical diagnosis, particularly in view of the roentgenologic findings (to be discussed). The figure given for the incidence of anorexia (41 per cent) may be somewhat low; all 6 of our patients experienced this symptom. Melena occurred occasionally.

Of the relevant laboratory data, the only changes which occurred with any consistency were hypochromic anemia and achlorhydria. The former was present in a mild or moderate degree in 85 per cent; the latter in 50 per cent of patients on whom these examinations were performed. The total white blood count and differential count were usually within normal limits. Eosinophilia was rare.

Table I

INCIDENCE OF OUTSTANDING SYMPTOMS IN GASTRIC HODGKIN'S DISEASE

(52 Cases)

	Per Cent
Epigastric pain	84
Weight loss	81
Anorexia	41
Nausea and/or vomiting	38
Weakness	21
Diarrhea	12

Table II

SITES OF GASTRIC LESIONS

(52 Cases)

	Per Cent
Antrum only	45.0
Entire stomach	20.0
Antrum plus pars media	12.5
Pars media only	7.5
Cardiac end only	7.5
Pars media plus cardiac end	7.5

Site of Lesions. The incidence of involvement of the various portions of the stomach is shown in Table II.

Lesions which involved the cardia extended to the lower esophagus in several cases (Pirkey and Roberts; Scott and Forman). Those involving the antrum extended similarly into the duodenal bulb in a number of instances (Singer; Koenig and Culver).

The lymph nodes along one or both curvatures were involved in practically all patients, although, in several, they were apparently free of disease (Supino; Browne, etc.).

Gross Pathology. The cases reported can be grouped into three more or less distinct morphologic types:

(1) Infiltrating: Infiltration and thickening of the gastric wall was the most frequent type of lesion and occurred in 60 per cent of cases reported. Of all these, about 50 per cent were localized to one segment of the stomach, usually the antrum; the remainder involved most or all of the stomach. When infiltration involved the body or fundus, the gastric rugae were usually prominent, stiff and thickened; however, in the antrum where the folds are normally smaller, they tended to be obliterated. Small, nodular elevations were frequently

scattered over the mucosa. Sometimes one or more of these were as large as 1 to 2 cm. in diameter, but more often they were much smaller so that they were not apparent on barium studies. Virtually all of the infiltrating lesions showed shallow superficial ulcerations or erosions, which were usually extensive. The only exceptions were the small and presumably early lesions, as in the case described by Comando.

(2) Polypoid: These also were commonest in the antrum and body. They varied in size from 5 to 10 cm. in diameter and occurred in 20 per cent of the patients reported. Practically all were ulcerated near the apex. The adjacent gastric wall often showed infiltration, and sometimes small satellite nodules were evident around the main lesion.

(3) Ulcerating: In these cases the outstanding lesion was a large deep ulceration usually in the antrum or body, occurring in 20 per cent of patients. Some of the ulcers had a maximum diameter of 9 cm. There was always some infiltration of the surrounding wall. In one of our own cases (Case 11), the Hodgkin's disease appeared to arise in the margin of a large peptic ulcer.

Roentgenologic Diagnosis. The anatomic changes observed on barium meal examination reflect the morphologic changes described, so that nothing can be gained from enumerating them in detail. Unfortunately, the lesion of Hodgkin's disease seen roentgenologically simulates carcinoma so closely that in most patients a differential diagnosis is impossible. In the case of deep ulceration with surrounding infiltration, carcinoma probably will be the only diagnosis considered. The circumscribed tumor will simulate, at times, a benign gastric tumor such as leiomyoma, when no surrounding infiltration is apparent. In the infiltrating type, however, suspicion may be aroused of a lesion other than carcinoma. Infiltrating Hodgkin's disease (as in the more common lymphosarcoma) differs from infiltrating carcinoma in three respects. In Hodgkin's disease (a) peristalsis, though sluggish, is often preserved; (b) there is less tendency to produce a fixed narrowing of the lumen; (c) nodularity or polypoid changes of the mucosa in the involved region occur much more frequently.

The superficial variety of gastric carcinoma may also retain these two features; the underlying reason in both cases is the same, *i.e.*, the gastric muscle is not sufficiently involved to have lost its functional capacity completely.

Treatment and Prognosis. Practically all patients in whom definitive treatment was attempted have undergone surgical resection as a natural consequence of the fact that the lesions usually were considered to be carcinoma until histopathologic examination established the diagnosis of Hodgkin's disease. It is clear that lengthy survival periods can be achieved by resection in favorable cases, with or without radiation therapy even when limited lymph node metastasis is demonstrated. This is illustrated by two of Madding's patients who were living six and eight years, respectively, after resection, despite local lymph node involvement. Far too few patients have been followed for an adequate period to establish even an approximate five year survival rate; but where the initial response was satisfactory, a considerable number survived several years at least.

Postoperative roentgen therapy to the local lymph drainage areas would appear to be indicated in view of the known response of Hodgkin's disease, and the prevalence of lymph node involvement. However, it has been employed in too few instances to establish its value. Primary roentgen therapy might be considered where the diagnosis can be established previously (*e.g.*, by gastroscopic biopsy) or in presumptive cases where Hodgkin's disease has been demonstrated in superficial nodes and the patient is a poor surgical risk. No cases of Hodgkin's disease of the stomach proved histopathologically and treated by roentgen therapy alone have been encountered in our review of the literature. Although 1 patient with Hodgkin's granuloma

(Case VI) in our series was so treated, the disease progressed. There is a report by Craver and Herrmann of 1 case (presumably Hodgkin's granuloma of the stomach) that did respond favorably to primary roentgen therapy. A woman, aged twenty-nine, had experienced "gastric distress and diarrhea" two and one-half years after a diagnosis of Hodgkin's disease in neck and mediastinal lymph nodes had been made. Gastroscopy showed "nodular and linear infiltration in the pars media with hemorrhages." "High voltage x-ray therapy" was given. Symptoms disappeared and two months later there was no evidence of the lesion by gastroscopy. The patient remained well for five and one-half years except for continued enlargement of a cervical lymph node. It is highly probable that this case represents a satisfactory response to primary roentgen therapy for gastric Hodgkin's disease even though the dosage was moderate. The diagnosis of gastric Hodgkin's disease was presumptive, since no histopathologic study of the lesion was obtained.

It is possible that primary roentgen therapy might constitute satisfactory management of gastric lesions, presumably due to Hodgkin's disease, on the basis of demonstrations of concurrent or previous involvement elsewhere. However, there are insufficient case reports for a positive statement.

SMALL INTESTINAL LESIONS

Hodgkin's disease of the small intestine formed the second largest group of gastrointestinal lesions. We have found 45 cases reported in the literature and add 1 of our own. In a number of other instances the small intestine was reported involved in conjunction with the stomach or colon, or both, but these cases have been eliminated from the series.

The morphologic types were similar to those found in the stomach. The infiltrating variety comprised 60 per cent of the total group, the ulcerating type 14 per cent, and the polypoid tumors 26 per cent.

The duration of symptoms was less prolonged than for lesions of the stomach: In 37 per cent of shorter duration than three months, in 26 per cent from three to six months, and in 37 per cent symptoms persisted from six to twenty-four months.

Table III

PREDOMINANT SYMPTOMS IN 45 CASES OF HODGKIN'S DISEASE OF THE SMALL INTESTINE

1. Abdominal pain
2. Diarrhea
3. Vomiting
4. Distention
5. Loss of weight
6. Fever
7. Palpable mass
8. Evidence of peritonitis
9. Exsanguinating hemorrhage

The symptoms associated with small intestinal lesions are summarized in Table III.

The commonest site in the small intestine is the jejunum or proximal ileum as shown in Table IV.

In a larger number of cases the duodenum was involved in continuity with the jejunum, and in a few cases with the gastric antrum.

Duodenal lesions were available for study in 6 cases, and were characterized by rapid onset of symptoms, and accompanied by a short history varying from several days to several months.

A brief summary is presented in Table V.

The distribution of the remaining small intestinal cases according to clinical manifestation is shown in Table VI.

Both acute and chronic obstruction were reasonably common. Among the former a frequent cause was intussusception due to

Table IV

DISTRIBUTION OF SMALL INTESTINAL LESIONS

	Per Cent
1. Duodenum	12.5
2. Jejunum or proximal ileum	55.0
3. Terminal ileum	20.0
4. Entire small intestine	12.5

TABLE V

SUMMARY OF 6 CASES OF HODGKIN'S DISEASE OF THE DUODENUM

Author	Lesion	Symptoms	Remarks
1. Chini	Infiltration 2nd and 3rd parts with ulceration	Severe epigastric colic, remittent fever, jaundice	Postoperative death
2. Kanner	Diffuse infiltration and ulceration	Vague abdominal pain; clinical diagnosis "appendicitis"	Postoperative death
3. Marchand and Guibert	Stenosing infiltration 3rd part	Epigastric distress; weight loss	Alive and well 9 mo. after resection
4. Paltauf (Case 2)	Ulcer 2nd part	Epigastric distress; weight loss	Death without resection
5. Vasiliu	Ulcer 2nd part, duodenitis, peritonitis	Acute abdominal symptoms; clinical diagnosis acute pancreatitis	Postoperative death
6. Jackson and Parker	Infiltration 2nd and 3rd part	Weakness, vomiting; rapid weight loss	Death from disease

a polypoid tumor. The borderline between chronic obstruction and "enteritis" types was necessarily somewhat vague. We have classified as "obstructing," cases in which vomiting was a major discomfort, and as "enteritis syndrome" those instances characterized mainly by diarrhea. Perforation was common in both the ulcerative and infiltrative types. Exsanguinating hemorrhage occurred in a few cases but was rare in relation to the group as a whole.

Roentgenologic Diagnosis. The changes observed in the course of barium examination of the small intestine depended, as in the stomach, on the morphology of the particular lesion and the presence or absence of obstruction. No specific features were demonstrated. The more localized lesions will probably be diagnosed as carcinoma or lymphosarcoma; the more diffuse lesions as regional enteritis. However, if one is aware of the morphologic types encountered, the possibility of Hodgkin's disease of the intestine will be considered when such a lesion is associated with proved involvement of superficial lymph nodes.

TABLE VI

SMALL INTESTINAL LESIONS CLASSIFIED BY CLINICAL SYNDROMES

(39 Cases)

	Per Cent
1. Small intestinal obstruction	45
2. Enteritis syndrome	20
3. Peritonitis following perforation	18
4. Symptoms suggesting appendicitis	5
5. Unclassified	12
	100

Prognosis and Treatment. The prognosis is less favorable than for gastric lesions. Forty per cent of patients were beyond assistance when first seen and died without treatment. More than half of the remainder died following laparotomy. The prevalence of obstruction, perforation or severe diarrhea is responsible for a poor prognosis, although a number of patients did survive resection. Many were dead less than six months later. Others were lost to follow-up. The longest survival reported is that of a patient of Biebl, who remained well for five years following resection of a jejunal lesion, and then underwent a second resection for a recurrence from which he again recovered. Our own patient having Hodgkin's granuloma (Case VII) remains

TABLE VII

SUMMARY OF 8 CASES OF HODGKIN'S DISEASE OF THE COLON

Author	Lesion	Symptoms	Remarks
1. Jackson and Parker	Mass involving appendix and cecum	Weight loss, melena constipation and diarrhea, pain and mass	Resection, postoperative death
2. Pisseru (Case 1)	Infiltration of cecum	Five attacks of "appendicitis" in 2 years	Appendectomy; postoperative death
3. Braine	Infiltration of cecum	Pain and mass right lower quadrant	Resection. Well 4 years later
4. Pilotelos	Infiltration of cecum	Clinical diagnosis: "acute appendicitis"	Appendectomy; postoperative death
5. Pape	Infiltration at splenic flexure, with perforation	Peritonitis	Dead when reported
6. Stoyalowski (Case 2)	Mass in colon with adherent small intestine	Abdominal pain; distention	Resection. Living 2 years later
7. Siegmund (Case 1)	Ulcerating mass in rectum	Clinical diagnosis: "carcinoma"	—
8. Gallart Mones and Roca de Vinals	Circumscribed tumor on rectum. Smaller nodules near by	Tenesmus, mucosanguineous discharge, weight loss, melena	Dead when reported

well twenty months following resection and postoperative roentgen therapy. We believe this to be the treatment of choice for operable lesions for the same reason recognized in gastric Hodgkin's disease. Inoperable lesions should receive a trial of roentgen therapy.

LESIONS OF THE COLON

With the exception of the esophagus, the colon is the most infrequent site of solitary gastrointestinal lesions in Hodgkin's disease. We have found only 8 such cases reported in the literature. These are summarized in Table VII. Several authors have mentioned other instances, but case reports are not available. There are also a number of reviews which discuss combined involvement of the terminal ileum and cecum, and many reports of colon involvement associated with lesions at other levels in the gastrointestinal tract. No instance of Hodgkin's disease of the colon was found in our own series; however, in Case VIII paracecal tissues were infiltrated by Hodgkin's sarcoma producing a defect and the appendix was involved.

The morphologic characteristics are similar to those in the stomach and small intestine.

Lesions of the cecum or ileum and cecum are apt to be confused clinically with appendicitis and, roentgenologically, with carcinoma, tuberculosis or other inflammatory lesions. Elsewhere in the colon the circumscribed lesions resemble carcinoma and the diffuse lesions resemble ulcerative colitis. Resection with postoperative roentgen therapy would again appear to be the treatment of choice.

REPORT OF CASES

CASE 1. A man, aged fifty-nine, was first seen at the Cleveland Clinic on January 22, 1948, complaining of anorexia, weakness and postprandial epigastric distress with persistent

A

FIG. 1. Case 1. (*A*) Abnormal mucosal pattern in body of stomach, irregular deformity along both curvatures. (*B*) Gross specimen. Hodgkin's sarcoma, ulcerating and infiltrating gastric wall.

eructation for seven months. He had lost 30 pounds in that period. Physical examination showed evidence of weight loss and a temperature of 99° F.; otherwise he was normal. There was no superficial lymphadenopathy. The blood was normal. The test meal showed achlorhydria and 4 plus fresh blood. Roentgenologic examination of the gastrointestinal tract was reported as follows: Stomach shows abnormal mucosal pattern in the body with irregular infiltration along both curvatures (Fig. 1*A*).

Impression. Carcinoma of the body of the stomach. The chest, gallbladder, colon, and flat plate of the abdomen were normal.

A laparotomy was performed on February 2, 1948, and the stomach was found to be diffusely involved by a neoplastic lesion, with enlarged lymph nodes along both curvatures. A total gastrectomy was performed.

Immediate postoperative course was uneventful following discharge. Roentgen therapy was given elsewhere. His course was continuously retrogressive with progressive weight loss until his death June, 1949, eighteen months after admission.

Pathologic Examinations (Fig. 1*B*). The specimen was a totally resected stomach 24 cm. in

B

length on the greater curvature. A tumor mass was palpable over a wide area of the body, including the lesser curvature and much of the anterior and posterior walls, and on section the wall was found irregularly infiltrated over an area 15 by 14 cm. In this region the mucosa was irregular with coarse, rounded elevations of tan color and with small hemorrhagic areas and indefinitely outlined shallow ulcerations. The gastric wall was thickened to a maximum of 4 cm. on the lesser curvature. The tissue was firm, rubbery and the sectioned surface bulging, glistening, gray-white and of "fleshy" appearance. Infiltration was evident a few millimeters from the proximal line of resection on the lesser curvature; the distal line was 7 cm. from the tumor mass. The fat tissue on the lesser curvature was infiltrated in several areas; the lymph nodes were enlarged and presented glistening, slightly everted, pearl gray cut surfaces. One such lymph node adjoined the pylorus.

Pathologic Diagnosis. Hodgkin's sarcoma of the stomach, body aspect, and lymph nodes of lesser curvature.

Fig. 2. Case II. Irregular filling defect from pylorus to cardia due to Hodgkin's granuloma.

Case II. A man forty-seven years old was first seen in the Cleveland Clinic in August, 1944, complaining of intermittent nausea for two years and anorexia of several months' duration. In addition, he had had pain in the right anterior side of the chest for three months, intermittent vomiting for two weeks, recent tarry stools, and had lost 40 pounds in weight. Physical examination was negative except for evidence of weight loss. There was no superficial lymphadenopathy. The blood was normal. A "test meal" was not done. Roentgenologic examination showed "an infiltrating lesion extending from the pylorus to within 3 or 4 cm. of the cardia" (Fig. 2). The impression was infiltrating carcinoma. The gallbladder, colon, and flat film of the abdomen and chest were normal. Laparotomy was performed on October 10, 1944, and revealed an infiltrating neoplasm of the stomach with enlarged lymph nodes along both curvatures. A gastric resection was performed.

The patient was discharged following an uneventful postoperative course. He appeared well at subsequent follow-up examinations and the blood count was normal. Progress barium meal examinations showed no recurrence. In January, 1948, he returned complaining of cough for six months, sweating and afternoon fever which had persisted for one year. Examination at this time showed enlarged lymph nodes in the left supraclavicular region, both axillae and the left groin. Roentgenograms showed middle lobe atelectasis. On January 14, 1948, a supraclavicular lymph node was excised and histopathologic examination revealed Hodgkin's granuloma. Following this, he was given roentgen therapy elsewhere. In September, 1948, he returned complaining of abdominal pain and weakness and a large mass was palpable in the left upper quadrant. He was discharged to receive roentgen therapy and, later, nitrogen mustard elsewhere. The response was poor, however, and he died on March 29, 1949, five years after admission.

Pathologic Examination. The surgical specimen removed at the first operation consisted of the distal portion of the stomach. Immediately proximal to the pylorus, and centered on the greater curvature, was a large irregular ulcer 9.2 by 4.3 cm. and 1.5 cm. in depth. The stomach wall was thickened throughout and in the region of the ulceration was replaced by pinkish-white tissue with smooth, glistening cut surfaces. The proximal line of resection was 2 cm. from the margin of the ulcer; the distal line was separated from it by the pylorus and duodenal cuff. Lymph nodes in the fat tissue of greater and lesser curvatures were not enlarged.

FIG. 3. Case III. Irregularity in midportion of stomach, distortion of rugal pattern, ulcer on lesser curvature due to Hodgkin's granuloma.

Pathologic Diagnosis. Hodgkin's granuloma of stomach; chronic ulcer with scar of muscularis.

A supraclavicular lymph node was removed approximately three and a half years later. It was 9 cm. in diameter, encapsulated and with a moist, tan cut surface.

Pathologic Diagnosis. Hodgkin's granuloma of lymph node.

CASE III. A forty-eight year old man was first examined at the Cleveland Clinic on January 9, 1952, complaining of weakness and weight loss beginning six months previously. At that time he had been admitted to another hospital where he was given a thorough examination, including routine laboratory studies, urogram, electrocardiogram, roentgenologic examinations of the chest and gastrointestinal tract, all of which were reported as having been normal. A biopsy specimen of an inguinal lymph node was diagnosed as chronic inflammation. After a few months he developed anorexia and a dull aching pain in the epigastrium. He was re-admitted to the same hospital where the gastrointestinal tract was re-examined, and he was advised he had an "ulcer of the stomach." When admitted to the Clinic, the significant findings were a large left axillary lymph node and several small lymph nodes in the right axilla and both inguinal regions. Biopsy specimen of the left axillary node was reported as chronic inflammation. Routine laboratory studies were normal except for a red blood cell count of 4.3 million and a hemoglobin of 70 per cent. Gastric analysis was not made. Barium meal examination showed a definite irregularity in the midportion of the stomach with distortion of rugal pattern and ulceration on the lesser curvature side (Fig. 3). Peristalsis was diminished but still present in the involved region. The impression was carcinoma of the stomach. The chest films were normal.

An exploratory laparotomy was performed on January 10, 1952, and an inoperable gastric neoplasm with multiple lymph node involvement was disclosed. Biopsy of the gastric wall was reported as Hodgkin's granuloma.

Roentgen therapy was begun on February 1, 1952. The upper abdomen was cross-fired with two anterior oblique and two corresponding posterior oblique portals (12 by 15 cm.). The anterior portals each received 3,100 r (skin dose) and the posterior each 2,850 r (skin dose). Over-all treatment time was thirty-nine days. Two fields were treated daily, alternating anterior and posterior pairs, 250 r per day. The physical factors were: 250 kv., half-value layer 1.9 mm. of copper. The patient was discharged on an ulcer regimen.

At progress examination on April 7, 1952, he had a large firm mass in the epigastrium and large lymph node in the left femoral triangle. In view of the poor response to roentgen therapy, a course of nitrogen mustard was given in four daily intravenous doses of 6.5 mg. starting on April 25, 1952, together with transfusions because of anemia; cortisone was prescribed (50 mg. q. 6 hr.) after which he temporarily improved but died six months after admission.

Pathologic Examination. The biopsy specimen from the gastric wall was formed by several fragments, the largest was 0.5 by 0.5 cm., soft in consistency and tan colored.

Pathologic Diagnosis. Hodgkin's granuloma (biopsy of gastric wall). Chronic inflammation of lymph nodes.

CASE IV. A fifty-six year old woman was first seen at the Cleveland Clinic in May, 1951. Two years previously she had developed bilateral swelling of the parotid, submaxillary and lacrimal glands, thought to be Mikulicz's disease, and simultaneously an abdominal mass. Roentgen therapy was applied to these regions in

another institution. Later she experienced anorexia and 45 pounds loss in weight. She complained also of an ache in the epigastrium experienced mornings and relieved by eating. The significant findings on physical examination were bilateral small axillary lymph nodes. The blood was normal. Gastric analysis showed achlorhydria. On barium meal examination a large polypoid filling defect was seen in the body of the stomach (Fig. 4*A*). The impression was polypoid carcinoma. Roentgenologic examinations of the gallbladder, colon and chest were normal. Gastroscopy showed multiple polypoid tumors in the distal three-fourths of the stomach, apparently covered by normal mucosa in some areas and by necrotic material in others. The impression was lymphosarcoma.

Laparotomy on June 4, 1951, disclosed an extensive infiltrating and polypoid neoplasm of the distal three-fourths of the stomach, together with numerous large lymph nodes along both curvatures. A gastrectomy was performed.

Postoperative roentgen therapy was begun on June 18, 1951. The physical factors were 250 kv., filter equivalent to half-value layer 1.9 mm. Cu; distance 80 cm., field size 10 by 15 cm. The dose was 250 r per day to a total of 2,600 r skin dose applied to anterior and posterior fields.

The patient was seen in May, 1952, without complaints and no palpable enlarged nodes or abdominal masses.

Pathologic Examination. The specimen was a portion of stomach, 14 cm. in length on the greater curvature (Fig. 4*B*). In the body, and extending to the proximal line of resection, the wall was thickened over an area 8 by 8 cm. Rugations in this area were broad and thickened and there was slight superficial ulceration. On section the gastric wall in the area was pale tan colored, and moist when sectioned. Lymph nodes in the fat tissue of the curvatures and in the omentum were enlarged to as much as 2 cm., were distributed singly and in clusters and on section were pale tan and moist.

Pathologic Diagnosis. Hodgkin's granuloma of stomach and lymph nodes of curvatures and omentum.

Comment. The lesion in the lymph nodes and in part in the stomach was evident as a diffuse infiltration of lymphocytes with scattered Reed-Sternberg cells and resembled Hodgkin's paragranuloma. However, sections of gastric wall were found with the

A

B

FIG. 4. Case IV. (*A*) Large polypoid filling defect in body of stomach. (*B*) Gross specimen. Thickened rugations, superficial ulcerating due to Hodgkin's granuloma.

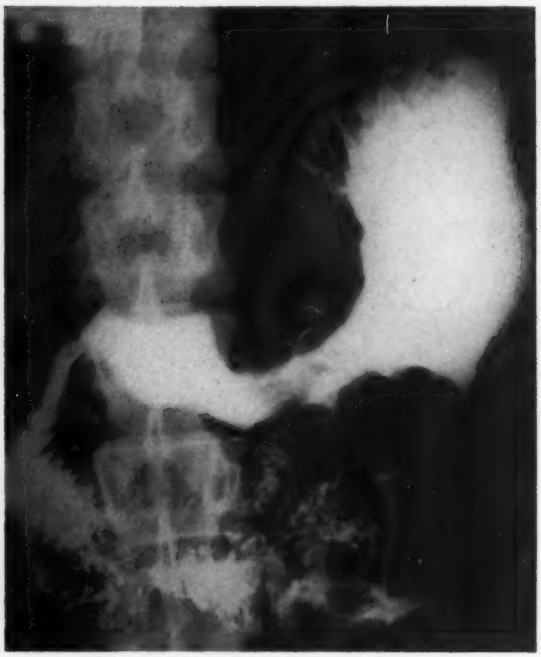


FIG. 5. Case v. Large filling defect caused by ulceration of Hodgkin's granuloma.

typical structure of Hodgkin's granuloma, even in nonulcerated areas.

CASE V. A thirty-seven year old man was first seen at the Cleveland Clinic in September, 1941, complaining of epigastric pain of three years' duration and loss of 24 pounds in weight. Roentgenograms of the stomach made one month previously at another hospital had shown a "large pyloric filling defect" (Fig. 5).

Physical examination revealed only evidence of weight loss. There were no palpable lymph nodes. The blood findings were as follows: red blood cell count 4.9 million, hemoglobin 65 per cent, white blood cell count 12,750, with 90 per cent neutrophils, 7 per cent lymphocytes and 3 per cent eosinophils.

At laparotomy on September 12, 1941, the stomach was found to be involved by a "large, ulcerated, tumorous lesion," and enlarged lymph nodes were present along both curvatures. A subtotal resection was performed.

Following his discharge the patient received a course of roentgen therapy elsewhere. He gained weight and felt well until April, 1942, when he began to lose weight again. He declined rapidly and was readmitted to the Clinic Hospital in June, 1942, in extremis. His red blood cell count had fallen to 1.2 million, hemoglobin 26 per cent. In spite of supportive measures he lapsed into coma and died twenty-four hours later, nine months after operation.

Gross Examination. The specimen consisted of the distal portion of the stomach with a short segment of duodenum and measured 20 cm. along the greater curvature. A firm tumor mass was present in the distal body, pyloric antrum and vestibule, 10.0 cm. in length, 6.0 cm. in transverse diameter, centered on the lesser curvature. The proximal line of excision was 1.0 cm. from the neoplasm and the distal line was separated by a cuff of duodenum 1.0 cm. in length. Sections showed white tumor tissue replacing the bowel wall entirely on the lesser curvature, but without extension into fat tissue. Numerous enlarged lymph nodes were present along the greater and lesser curvatures, the largest 2.0 cm. in diameter.

Diagnosis. Hodgkin's granuloma of the stomach and of lymph nodes of the curvatures.

CASE VI. A fifty-six year old man was first seen at the Cleveland Clinic on June 1, 1950, complaining of epigastric pain, tenderness and anorexia for the past year. A diagnosis of "stomach ulcer" had been made elsewhere eight months previously. He had lost 20 pounds in weight since the onset of his illness. Physical examination was negative. Barium meal examination showed a constricting, infiltrating lesion in the antrum with ulceration (Fig. 6*A*). Routine laboratory examinations, including blood count, hemoglobin and gastric analysis, were normal. At laparotomy on June 12, 1950, an extensive infiltrating, ulcerating gastric lesion was found, with lymph node enlargement on both curvatures. The stomach was resected.

Roentgen therapy to the gastric region was started on June 22, 1950. Two 15 by 20 cm. transverse fields were employed, one in the epigastrium and the other posteriorly at the same level. The fields were alternated daily, each receiving 250 r per treatment for a total of 2,500 r each (skin dose) in twenty-five days. The physical factors were: 250 kv., half-value layer 1.9 mm. of copper. He was given a second similar course of roentgen therapy elsewhere at a later date. His subsequent course has been satisfactory. When last seen on September 10, 1952, he was symptom-free, and barium meal examination showed no recurrence or enlarged lymph nodes.

Pathologic Examination. The specimen consisted of a portion of a stomach, 17.5 cm. in

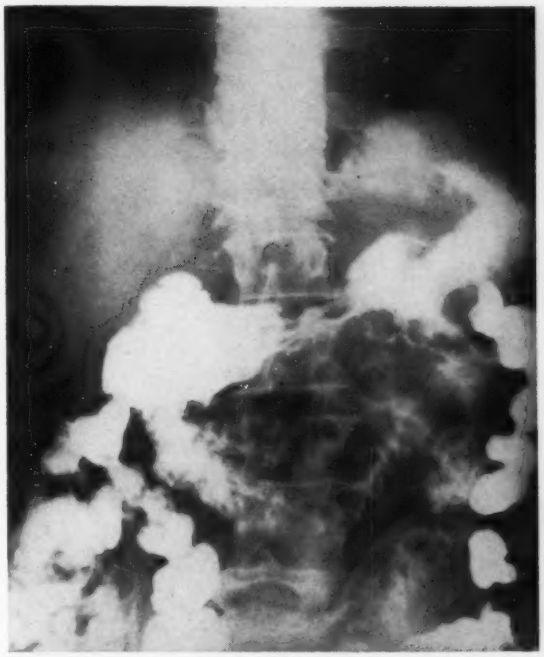
length on the greater curvature (Fig. 6*B*). There was a doughy thickening of the wall in the region of the distal body, pyloric vestibule and antrum. The serosa was smooth. The mucosa in this distal portion in a zone about 5 cm. in width, beginning at the pylorus, showed an irregular large shallow depression involving 80 per cent of the circumference including the lesser curvature and all of the posterior wall. The mucosal surface was pale tan in this area. The sectioned gastric wall was irregularly thickened to a maximum of 8 mm. and was tan externally and gray on the mucosal aspect. The duodenal cuff and pylorus and the proximal gastric segment for a maximum of 4 cm. were of normal appearance. In the fat tissue of the curvatures there were scattered, enlarged lymph nodes, a maximum of 1.3 cm. in diameter, which were soft and on section tannish gray.

Pathologic Diagnosis. Hodgkin's granuloma of the stomach and lymph nodes of the curvatures.

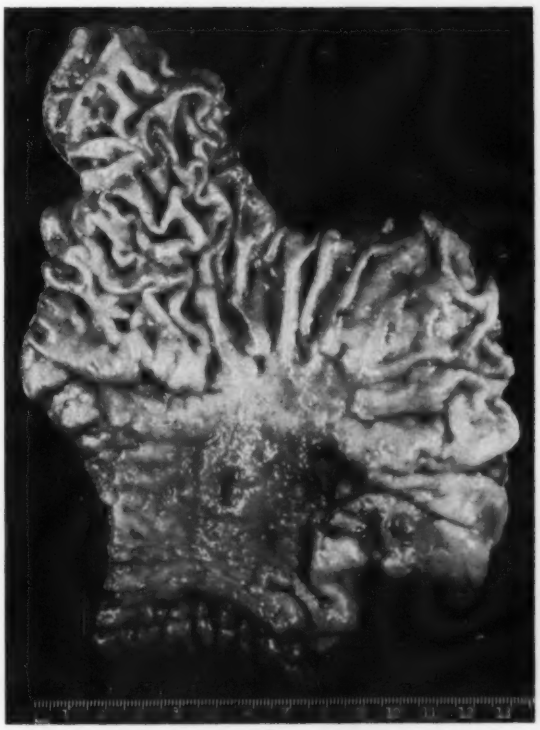
Case vii. A sixty-nine year old woman was first seen at the Cleveland Clinic on July 19, 1950, complaining of colicky right abdominal pain radiating to the epigastrium. The attacks of pain had begun about three months previously and recurred with increasing frequency, accompanied by nausea and emesis, and anorexia. She had lost 12 pounds in weight. Physical examination showed a small mass in the epigastrium. Relevant laboratory examinations, including blood counts, were normal. On barium meal examination a polypoid lesion was seen about 15 cm. beyond the ligament of Treitz with some dilatation of the small intestine proximally (Fig. 7*A*). The impression was lymphosarcoma of the jejunum. The chest examination was negative. On August 2, 1950, the involved segment of the jejunum was resected.

A course of roentgen therapy to the abdomen was started on August 15, 1950. The abdomen was cross-fired through two anterior oblique 15 by 20 cm. portals, each receiving 2,900 r (skin dose) in four weeks. The daily dose was 250 r to alternating portals. A direct posterior lumbar field received 2,000 r (skin dose) in eight days. The physical factors were: 250 kv., filter equivalent to half-value layer 1.9 mm. of copper. Since then the patient has gained weight and when last seen on September 2, 1952, two years after treatment, was apparently well.

Pathologic Examination. The specimen con-



A



B

Fig. 6. Case vi. (*A*) Constricting infiltrating lesion in antrum of stomach with ulceration. (*B*) Gross specimen. Large shallow depression in lesser curvature and posterior wall due to Hodgkin's granuloma.

A

sisted of a segment of jejunum 19 cm. in length, in the midportion of which was an annular tumor mass, 5 cm. (Fig. 7*B*). There was a constriction in this area, and the lumen was stenosed. The mucosa was locally ulcerated on the mesenteric aspect, including three-fourths of the circumference. On section the tumor was variably soft and firm, pink, and finely granular and infiltrated the bowel wall. The mesentery was greatly thickened to the line of resection, shortened in the region of the lesion, and included many enlarged lymph nodes. Lines of resection of the bowel appeared normal.

FIG. 7. Case VII. (*A*) Deformity of polypoid lesion in the jejunum near the ligament of Treitz causing dilatation. (*B*) Gross specimen. Above, constricting ulcerating lesion in jejunum. Below, mesenteric aspect showing constriction. Hodgkin's granuloma of jejunum.

B

Pathologic Diagnosis. Hodgkin's granuloma of the jejunum and mesenteric lymph nodes.

Case VIII. A thirty-six year old woman came to the Cleveland Clinic on November 6, 1951, complaining of pain in the right lower abdomen and fever of five weeks' duration. Physical examination revealed a tender mass in the cecal region, but was otherwise negative. Barium enema examination showed an irregular filling defect in the cecum and terminal ileum (Fig. 8). This was considered to be inflammatory. The patient was hospitalized and given antibiotics on the basis of a diagnosis of appendiceal abscess. The temperature returned to normal, symptoms subsided and she was discharged to the care of her family physician. She returned to the Clinic with recurrent symptoms, and a laparotomy was performed on January 9, 1952. A neoplastic mass was found in the cecal region and a right colectomy with end-to-side ileotransverse colostomy was performed. No other masses, enlarged lymph nodes or involvement of other organs were palpable.

Postoperative roentgen therapy was started on January 15, 1952. The lower abdomen was cross-fired through two anterior oblique and two corresponding posterior oblique 15 by 15 cm. portals. Each portal received a total of 2,000 r (skin dose) at the rate of 200 r per day, the anterior and posterior portals being treated on alternate days. The physical factors were: 250 kv., filter equivalent to half-value layer 1.9 cm. of copper, and the over-all treatment time was twenty-four days. At follow-up examination she complained of right upper quadrant pain, anorexia and afternoon temperature of 101 to 102° F. Because of the poor response to roentgen therapy, a course of nitrogen mustard was given in 4 daily doses of 5 mg. intravenously, beginning on April 4, 1952. Following this she became afebrile and was discharged. She was living eight months after operation.

Pathologic Examination. The specimens consisted of an appendix and a segment of ileum, cecum and ascending colon. The appendix was 6 cm. in length, with noticeably thickened wall. The serosa was glistening and pale; the mucosa was granular, pinkish tan and moist and the thickened wall glistening and grayish white on section. The proximal portion was dilated so that the circumference was 3 cm.; the lumen was tapered to the tip.

The intestinal segment was 28 cm. in length, the large intestine measuring 20 cm. Immediately adjoining the cecum and infiltrating the fat tissue was a firm mass 5 by 4 by 3 cm. formed by conglomerate nodules with grayish white smooth glistening cut surface of "fish-flesh" appearance. The mucosa of the cecum, colon and ileum were of usual character.

Fig. 8. Case VIII. Irregular filling defect in cecum and terminal ileum caused by Hodgkin's sarcoma of appendix and paracecal tissues.

Pathologic Diagnosis. Hodgkin's sarcoma of the appendix and paracecal tissues.

SUMMARY

1. Hodgkin's disease may first be manifested in the gastrointestinal tract.

2. The literature regarding Hodgkin's disease of the gastrointestinal tract has been reviewed.

3. Eight cases of Hodgkin's disease of the gastrointestinal tract occurring as the primary manifestation have been reported. In six patients the first manifestations appeared in the stomach, in the jejunum in one, and in the ileocecal region in one.*

Our experience and that reported in the

* As this article was being completed a report of a case of Hodgkin's sarcoma of the jejunum was found in *The New England Journal of Medicine*, 1951, *244*, 763–776. Also a case of "Gastric Hodgkin's Disease" was reported by W. Ross Morris. *J.A.M.A.*, 1952, *149*, 1460.

literature indicate that lengthy survival periods can be achieved by resection in favorable cases, with or without radiation, even when limited lymph node metastasis is demonstrated.

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CALCIFICATION WITHIN THE STOMACH WALL IN GASTRIC MALIGNANCY*

CASE REPORT AND REVIEW OF LITERATURE

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THIS department had occasion recently to examine a patient presenting diffuse nodular and punctate calcifications within the mass of a gastric malignancy. Although the appearance of the stomach left little doubt as to the nature of the lesion, the presence of pronounced calcification within the tumor did invoke a question in our minds as to the association of the gastric mass with the calcified densities. The relationship of gastric neoplasm and calcification is of exceedingly rare occurrence.

A review of the literature substantiated the apparent rarity of this roentgen finding. We have been unable to find any case of roentgenographic demonstration of calcification in a stomach neoplasm having been reported in the American medical literature. Review of the foreign literature revealed that in 1939 Abel[1] reviewed 2 cases, 1 proved, and 1 probable, and added his own proved case. Four other cases have been reported, 1 by Reidel,[12] 3 by Tenconi.[13] The purpose of this paper is to review these cases and add another to the meager list thus far reported, making the eighth reported case, the sixth proved one.

Several additional cases, discovered on pathologic examination without roentgenographic study, have been reported[4,7,11] but are not discussed here.

CASE REPORT

The patient, a white male, aged forty-seven, was first seen by his private physician on September 6, 1951, complaining of evanescent upper abdominal distress and bloating shortly after eating. The patient had recently been involved in an automobile accident, and the possibility was entertained that these symptoms could have been attributed to the emotional anxiety related to this episode. He was seen again one month later, when further history determined the persistence of slight upper abdominal distress, most marked after food intake. No other gastrointestinal complaints were elicited. Roentgenoscopic examination after ingestion of barium revealed contraction of the gastric lumen, and disruption of the mucosal pattern. A complete gastrointestinal examination made elsewhere was interpreted as "linitis plastica" of the stomach and pancreatic calcification plastered to the posterior wall of the stomach.

He was admitted to the Michael Reese Hospital November 22, 1951, for further study and treatment. The past medical history was noncontributory, and at this time the patient manifested no weight loss, anorexia, nausea, nor vomiting.

Physical examination revealed a well developed, well nourished male, not apparently ill. No positive abdominal nor other findings pertinent to the present illness were observed. Laboratory tests revealed the following:

Examination	*Determination*	*Normal Limits*
Serum amylase	144.6 units	70–170 units
Serum lipase	25 units	15–60 units
Serum glucose	64 mg. %	70–105 mg. %
Serum urea nitrogen	21.6 mg. %	9–19 mg. %
Serum total protein	6.7 gm. %	6–8 gm. %
Serum albumin	4.2 gm. %	3.2–4.4 gm. %
Serum total globulin	2.5 gm. %	2.6–3.8 gm. %
Serology	Kahn method—negative	

Hematologic

Hemoglobin—12.8 gm. and 82%
Red blood cells—5,000,000
Hematocrit—38%
Mean corpuscular volume—76
White blood cells—6,400
Color index—82

Differential Count

Polymorphonuclear leukocytes	73%
Nonsegmented forms	5%
Lymphocytes	19%
Monocytes	3%
Abnormal red cell types	
Microcytes	2+
Anisocytes	1+
Sedimentation rate (normal—0 to 20)	20

* From the Department of Diagnostic Roentgenology, Michael Reese Hospital (Robert A. Arens, M.D., Director), Chicago, Illinois.

Roentgenologic Findings. Preliminary roentgenoscopic examination of the chest revealed no abnormalities. Examination of the upper gastrointestinal tract by means of a barium meal demonstrated a normal esophagus. There was an extensively infiltrating tumor involving the distal two-thirds of the stomach, with no evidence of delay in emptying time; indeed, a somewhat increased rate of evacuation of barium into the duodenum was observed because of a rigid patent pylorus. The cardia demonstrated marked coarsening of its folds and it was felt that this could represent additional tumor infiltration. Immediately posterior to the barium-filled gastric lumen and displacing it anteriorly, a large calcified mass was observed (Fig. 1). The calcifications were of a miliary punctate type, homogeneously distributed, adjacent to the lesser curvature of the stomach, extending superiorly for a distance of several centimeters. The relation of the calcified mass to the stomach (whether it invaded, extended from or was entirely separate) could not be determined with certainty from this examination. Although the mass lay anterior to the position normally occupied by the kidney, it could not be excluded as representing a retroperitoneal mass invading the stomach. Another possibility considered was a hemangiosarcoma invading the stomach, the nodular calcifications representing phleboliths.

Fig. 1. Film demonstrates the barium-filled gastric lumen with large calcified mass adjacent to its lesser curvature.

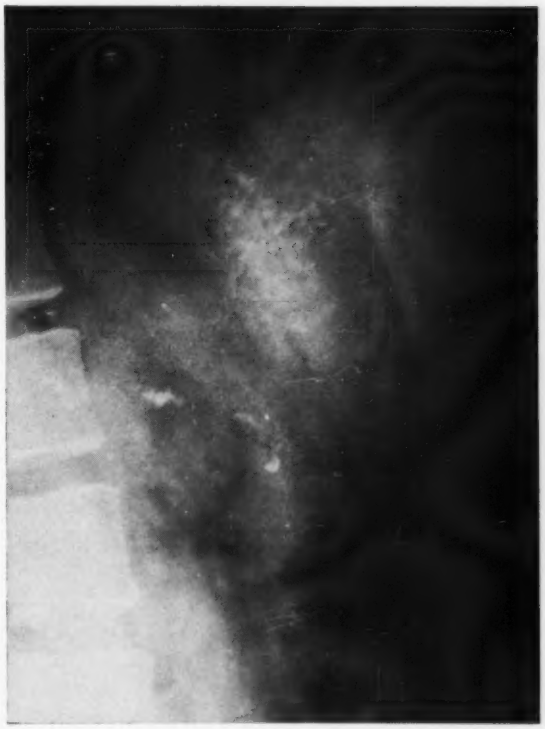

Fig. 2. A lateral film of the abdomen taken during an intravenous urogram discloses the calcified mass occupying the upper and anterior part of the abdomen.

The duodenal bulb when filled presented a normal outline, but contained somewhat coarser folds than usual. No tenderness was present over the stomach or duodenum.

An intravenous urogram demonstrated normal urinary tracts bilaterally and a lateral view showed the calcified mass (Fig. 2) to lie anterior to the left kidney, and apparently unrelated to it.

The impression gained was that the patient had a gastric malignancy, the relation of this to the calcification being of an indeterminate nature.

Hospital Course. On November 27, 1951, under general anesthesia the abdomen was explored. "The exploration of the viscera revealed a diffuse malignant involvement of the stomach. That part of the stomach on the lesser curvature side was entirely involved by a diffuse hard

Fig. 3. Roentgenogram of surgical specimen demonstrating extensive thickening of entire gastric wall with encroachment upon the gastric lumen. Note the presence of punctate calcifications overlying the body of the stomach in the region normally occupied by the incisura angularis and extending for a short distance along the lesser curvature.

tumor mass. Only a small part of the stomach on the greater curvature remained as original lumen. There was some infiltration of the lesser omentum. No metastases were found in the liver." On mobilizing the stomach," the posterior surface of the stomach was then visualized, and the entire surface was hard, yellowish and granular." After removal of the stomach, a loop of jejunum was brought up through a hole in the transverse mesocolon, and anastomosed to the end of the esophagus.

The postoperative course was complicated by a leak of the duodenal stump necessitating further surgery. Following this episode the hospital course was uneventful and the patient was discharged on December 20, 1951, fifty-three days following the initial operation. When last seen, five months following gastrectomy, and approximately seven months after first being seen by his physician, the patient was doing well.

Pathologic Report of the Operative Specimen. The serosa of the lower two-thirds of the stomach, chiefly along the lesser curvature, was studded with minute nodules and appeared thick and white. There were numerous adhesions involving the lesser and greater curvatures. On section of the specimen, it was seen that the mucosa of the entire stomach with the exception of the fundic portion was replaced by a tumor mass which involved all layers of the wall other than for the muscularis, which appeared to be grossly uninvolved. At the centermost portion of the tumor, there were no rugal folds, and the mucosa looked granular, opalescent and hemorrhagic. This process extended down to the pylorus and as a result there was marked narrowing of the lower two-thirds of the stomach. Attached to the duodenum, which appeared uninvolved, along the greater curvature, there were many small lymph nodes.

Microscopic examination of sections, taken from the inner aspect of the tumor (Fig. 5), demonstrated the gastric mucosa being replaced by low columnar cells, aligned in compact rows or occasional tubules. These cells had dense hyperchromatic nuclei, variable amounts of eosinophilic cytoplasm, often containing globules of basophilic (mucin) material. This material appeared to well up within these cells, compress the nuclei and penetrate the cell membrane. It permeated the entire stomach wall and extended into the perigastric fat tissue. A few signet ring cells and glandular structures persisted in the myxomatous material which was partitioned by bands of residual muscle or fibrous connective tissue, the whole being relatively acellular. Scattered throughout the material, there were isolated deposits of deeply basophilic material. In sections stained by von Kossa's method (Fig. 6) this material was shown to be calcium.

Microscopic Diagnosis. Mucinous adenocarcinoma of the stomach with extension to serosa, lymphatics and fat.

Report of Cases from the Literature

The earliest case of a calcified stomach neoplasm demonstrated roentgenographically was very briefly reported by Imbert[10] in 1931. Examination of the gastrointestinal tract to determine the cause of a mass in the left upper quadrant, associated with symptoms of dysphagia and a 6 pound weight loss in one year, revealed the pylorus of the stomach to be infiltrated, with rapid passage of the barium from the stomach. In addition, the entire viscus was infiltrated as high as the cardia and there was delayed

Fig. 4. Photograph of surgical specimen showing minute tumor nodules chiefly along the lesser curvature of the lower two-thirds of the stomach, corresponding to the area occupied by the dense calcifications in Figures 1 and 3.

entrance of contrast medium into the stomach. The barium-filled stomach was the site of what previous films of the abdomen showed to be two opaque bands, embracing a clear zone, suggesting a hollow organ with thickened calcified walls. The author presented no microscopic confirmation of his diagnostic impression, which was syphilitic linitis plastica. He mentioned an associated clinical finding of cartilaginous destruction of the nose to support his impression, although the blood Wassermann reaction was negative and no mention was made of previous antiluetic therapy. Carcinoma was also considered, and Abel[1] in commenting on this case, stated that this probably represented a carcinoma.

It may be recalled that in the early 1930s linitis plastica on a luetic basis was a frequently ventured diagnosis, although its incidence in autopsy material was quite small.

In 1937, Beliczay[2] presented his findings in the case of a thirty-five year old woman whom he had followed from 1933 to 1935 and who had ascites of undetermined etiology. Flat films of the abdomen showed calcification in the left upper quadrant and subsequent examination of the upper gastrointestinal tract demonstrated the walls of the stomach to be extensively infiltrated, its mucosa destroyed, peristalsis absent, and the pylorus incontinent. Calcium was deposited in the wall of the stomach like a coat, in decreasing amounts as the pylorus was approached. At operation, diffuse peritoneal nodular metastases, a fist-sized tumor connected to the left ovary, and a smaller right ovarian tumor were found. The stomach was replaced by a firm mass. Liver and gallbladder appeared normal. No biopsy of the stomach was performed. Biopsy of the ovaries showed Krukenberg tumor metastases. The author's impression was that he was dealing with a primary carcinoma of the stomach with calcium deposition.

Abel,[1] in 1939, rendered a rather complete report of a thirty-year old female, of Brazilian nationality, who in 1936 complained of epigastric pain, nausea and occasional vomiting after ingestion of food. These symptoms were attributed to hookworm infestation, ova of this parasite having been discovered in her stool. In November, 1936, it was determined that she was pregnant, and progressively severe

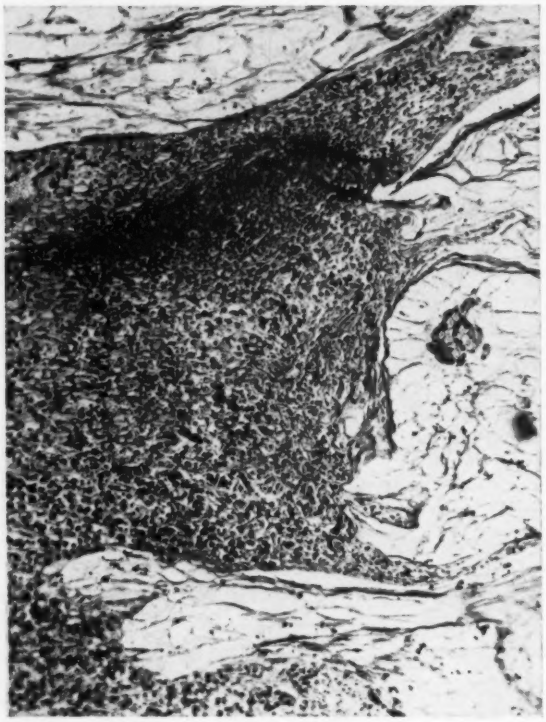

Fig. 5. Photomicrograph showing a section of the stomach wall demonstrating aggregations of cells with dense hyperchromatic nuclei occasionally compressed by cytoplasmic mucin. Myxomatous areas can be seen appearing as sheets of clear anuclear material. Hematoxylin and eosin stain ×70.

vomiting and anorexia were attributed to this. After delivery, these findings did not resolve, anemia and debility continued and carcinoma of the stomach was diagnosed. In June, 1939, 4,500 cc. of straw colored ascitic fluid was removed, and a left upper quadrant mass became palpable. Laboratory tests were noncontributory other than for the presence of a red blood cell count of 3.4 million.

Roentgenographic studies showed lentil shaped, small, spotty, diffuse calcifications extending from the fundus throughout the body of the stomach. The amount of calcification decreased distally, being greatest on the posterior wall near the greater curvature aspect of the proximal portion of the stomach. The barium-outlined gastric lumen was narrowed and there was thickening of the gastric wall. The antrum was narrowed, peristalsis absent, and the pyloric sphincter was insufficient. Pathologic examination demonstrated the stomach to be diffusely enlarged, the gastric wall being 2 cm. in thickness at the cardia, and approaching normal thickness at the pylorus. Only the cardia and pylorus demonstrated normal mucosa. In the remaining areas, the mucosa was ulcerated and the gastric surface was covered with disseminated pea-sized calcific encrustations. Cross section of the stomach wall showed marked infiltration of the submucosa, the muscularis propria being preserved. Microscopic examination showed a thickened submucosa traversed by tumor tissue, small tracts of round epithelial cells which lay isolated in well developed stroma, and in these areas, marked mucous formation. The calcifications occurred in nests wherein mucous ghost cells, nonnucleated tumor cells were seen. The calcifications represented calcium carbonate crystals. There was calcification in the lymphatic channels and palisading of calcification along the greater curvature wall corresponding to the lymphatics.

Reidel[12] reported calcification in a carcinoma of the stomach. A forty year old white female complained of severe epigastric pain of one and a half years' duration, which was alleviated by limiting food intake. On physical examination she presented a hard, nontender mass in the left upper abdomen, which moved synchronously with respiration. Serology was negative. On roentgenographic examination, a survey film demonstrated a fine nodular stippling of calcific density in the left upper quadrant of the abdo-

Fig. 6. Photomicrograph of a section stained by von Kossa's method, demonstrating calcification within mucinous material in the muscularis of the stomach wall. ×70.

men. Barium contrast meal demonstrated a mass in the cardia and along the lesser curvature of the stomach. Barium was retained in the esophagus due to obstruction at the cardio-esophageal sphincter and there was narrowing of the lumen of the vertical portion of the stomach. Mucosal folds in the upper half of the viscus were destroyed and the gastric wall was rigid in its upper half. The inferior half was pliable, but mucosal folds were not observed. The operative specimen demonstrated the upper half of the stomach replaced by a firm infiltrating mass, and the greater curvature and adjacent gastrocolic ligament was likewise infiltrated. A gastrojejunostomy was performed. A biopsy specimen demonstrated, on microscopic examination, a mucinous adenocarcinoma. Subsequently, at autopsy, a gastric mass was found, extending from the cardia to the pylorus. The entire wall was replaced by neoplasm. Nodular areas were noted on the peritoneal surface. Microscopic examination demonstrated a mucinous adenocarcinoma, which on its outer surface gave rise to calcified nodules.

In 1948 Tenconi[13] presented 3 additional cases of calcification within gastric neoplasms. One occurred in a twenty-seven year old male, with a diffuse infiltrating neoplasm extending from the antrum throughout the body of the stomach, which showed small dense shadows between the lesser curvature of the stomach and the vertebral column. To explain the presence of these densities, the possibility of a perforation of the stomach occurred to this examiner, with passage of barium into the adjacent soft tissues. A survey film taken at a later date showed no change in the distribution of these densities. Additional calcifications, no longer obscured by barium, were seen. At operation a gastric neoplasm was found involving the anterior wall of the stomach, the surface of which presented white, multifaceted nodules. There was no evidence of perforation. Several nodes for biopsy were taken. The histopathologic report was mucinous carcinoma.

The second case was that of a forty-two year old male, complaining of epigastric pain of one month duration. The patient complained of anorexia, vomiting and weight loss. Roentgenographic examination demonstrated a gastric antrum neoplasm and superimposed on the stomach shadow multiple punctate calcific densities. Plain films of the abdomen showed their persistence. Surgery demonstrated a neoplasm involving the antrum of the stomach, the surface of which showed white calcific nodules. The microscopic report of the surgical specimen was mucinous carcinoma of the stomach.

The third and final case this author presents is that of a fifty-one year old male with a three year history of epigastric pain, anorexia and a 12 kilogram weight loss occurring during a two month period. The abdomen was enlarged, there was ascites and a mass in the umbilical area. Roentgenograms demonstrated an extensive carcinoma of the pylorus of the stomach and calcification in the region of the lesser curvature.

At surgery an antral neoplasm, the surface of which was studded with firm nodules, was discovered. Roentgenograms of the specimen showed these to be of calcific density. Histopathologic examination revealed a mucinous carcinoma.

DISCUSSION

In discussing the pathogenesis of dystrophic calcification (calcification in ischemic and necrotic areas) most basic textbooks[3,14] describe an environment conducive to calcification characterized by a relative alkalinity of the circulating extracellular fluid brought about by diminished cellular respiration with a concomitant diminished carbon dioxide production. This situation may result from an inadequate blood supply. Since the balance between calcium solubility and deposition as the salt depends, among other factors, on the pH of the medium (increasing as the pH is elevated)[3] this tendency toward an alkaline state of the environment would support calcium salt deposition. In addition, calcium and phosphate ions in solution tend toward deposition as their salt, when the product of their concentrations has exceeded a given amount. The source of the calcium might be the protein bound calcium of necrotic tumor tissue which, upon liberation, contributes toward building up a sufficiently high local calcium concentration to permit salt deposition. Most of the above described environmental conditions occur in many tumors, of varying cell types and arising from different organs, without the occurrence of calcification.

Hofmeister[9] observed that certain organic colloids seem to present an absorption affinity toward various crystalline substances. Gutman[8] points out that certain organic matrices are the sites of calcification, under proper environmental circumstances, because of their innate property of calcifiability. He experimented with calcification in the cartilage of the primary zone of calcification of a growing bone. Chem-

ically the cartilage is composed of a glycoprotein[5] capable of ion exchange. This principle of the ion exchange resin is discussed in basic organic chemistry textbooks.[6]

The above described environmental circumstances certainly do not fully describe the pathogenesis of calcification in any single case. Abel,[1] in attempting to determine the cause for calcification in his case, offered the possibility that the prolonged vomiting, manifested by his patient, resulted in a constant alkalosis, thereby furthering the possibility of calcium salt deposition. Reidel[12] offered a similar etiology. In our case no such history of vomiting was recorded.

What was of interest to us, in reviewing these case histories, was the fact that in every case these neoplasms were characterized by marked mucinous degeneration, and the calcification occurred only in areas of degeneration so characterized. One might conjecture upon the chemical relationship between the cartilage of the preliminary zone of calcification in growing bone with its propensity for calcification (as discussed by Gutman) and the chemical composition of mucin, both of which are very similar glycoproteins.

One might speculate without attempting to outline a complete pathogenesis for calcification, whether the presence of mucin, because of some innate property of calcifiability, possibly acting as an ion exchange resin, might have been the determining factor in calcification in our case. With information of this type available, a more satisfactory initial approach to the roentgenographic differential diagnosis would have been possible.

SUMMARY

1. An unusual case of calcification in a mucinous adenocarcinoma of the stomach has been presented.

2. Previous cases reported in the literature are reviewed.

3. Theories relating to the pathogenesis of calcification are discussed, and the frequency of its occurrence in mucinous carcinomas speculated upon.

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ORAL HEPATOSPLENOGRAPHY*

SOME LIMITATIONS OF IODINATED, CHLORIODIZED AND BROMIODIZED OILS HOMOGENIZED WITH VARIOUS EMULSIFIERS

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A SAFE contrast medium for roentgenography of the liver and spleen in man, which is so desirable, has yet to be found. Thorium dioxide sol[11,14] is a contrast medium of limited usefulness because of its radioactivity.[5] Iodine has been the basis of numerous contrast compounds.[3,12] It has been estimated that to obtain sufficient contrast of the spleen or liver not less than 200 mg. iodine per kilogram of body weight would be necessary. Beckermann[2] used 250 kg. in the human, which might amount to 20 gm. of iodine for the average man. Iodine liberated compounds, such as Beckermann used, can be toxic to sensitized individuals and there have been reports in the literature of more than 60 deaths from intravenous injections of iodine compounds.

Many attempts have been made to get iodine into the liver and spleen via iodinated fats, emulsified sufficiently to be taken up by the cells of the reticuloendothelial system. Keith and Briggs[9] studied hepatosplenography with iodized poppy seed oil (Lipiodol) and bromated olive oil emulsified by grinding in a mortar with 5 per cent gum acacia solution. They found dense splenic shadows one-half to one hour after intravenous injection and these shadows faded within a week. Without reference to Keith and Briggs' work, Beckermann and Popken[3] produced hepatosplenograms with emulsified ethyl ester of triiodo-stearic acid (Degkwitz solution) which, according to Grossmann and Cooray,[8] was made by Cadenbach. The solution was tried in humans but caused some deaths. It has been withdrawn from the market.

Emulsions of iodized oil with particle size larger than an erythrocyte, according to Keith and Briggs, may plug the lung capillaries. It is possible to obtain smaller particulate size with modern milk homogenizers, but there is a tendency to rapid coalescence of these particles. This may be prevented (a) by emulsifying agents, (b) by producing reduction in the size of the particles, and (c) by increasing the viscosity of the water phase of the emulsion.

Success has been achieved in "solubilizing" fat-soluble hormones[6] and vitamins (U.S. Patents 2,417,299 and 2,518,230). The greater the viscosity of an oil, however, the more difficult it is to homogenize and the addition of iodine increases viscosity, thus accentuating the difficulties of homogenization. Oils darken on iodination and these darkened oils are toxic. Green[7] has shown that iodine trichloride reacts with all natural oils, except castor oil, to liberate iodine. Special methods are required to lighten the color and detoxify these darkened oils. These are only a few of the obstructive hurdles to be taken before progress along this path of research can be anticipated.

EXPERIMENTAL

Our experiments were done on 218 mature rats; only a few experiments were done on rabbits. In humans, emulsions were given only by mouth. The oils used were Lipiodol, chloriodized oil, 27 per cent iodine and 7.5 per cent chlorine (Iodochlorol, Searle), iodized linseed oil (31.7 per cent iodine) and iodized falkidine methyl esters (46 per cent iodine) made by William French, Hormel Institute, Austin, Minnesota, bromiodized linseed, corn oils and lecithin made by one of us (J. F. McC.). The other substances used were ehtyl iodophenylundecylate (Pantopaque), chloroiodohydroxyquinoline, (Vioform), silver iodide, colloidal iron oxide (Proferrin), Proferrin with potassium iodide and zirconium oxides and phosphates.

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FIG. 1. This 200 gram rat was injected intravenously with 2 cc. of a 25 per cent emlusion of iodized linseed oil in 5 per cent Tween-Span solution, then 24 hours later given 10 cc. of a 5 per cent emulsion of the same oil by stomach tube and roentgenographed after 6 hours 20 minutes.

The emulsifiers used were blood serum, hemoglobin, ionic detergent (Alconox), polyethylene glycol (Carbowax), polyoxyethylene sorbitan-fatty esters (Tweens), sorbitan-fatty esters (Spans), hydrocarbon sodium sulfates (Tergitols), glyceryl monooleate, polyethyleneglycol 400 monooleate, polyglycerol oleate (Demal 14), lecithin, dextran, methyl cellulose (Methocel), bile salts and mixtures of these various emulsifiers.

The concentration of the emulsifier was chosen for ease of emulsification and for its stability. Alconox, the Tergitols, Carbowax and polyethyleneglycol monooleate were weighed out as 1 per cent of the water to be added. Lecithin and sodium taurocholate were 1 to 5 per cent of the water added. The Tweens or the mixture of one part Span-80 to three parts Tween-80 varied from 1 to 100 per cent of the water added.[13] Brieger[4] has pointed out that the non-ionic emulsifiers are relatively non-toxic, but Krantz *et al.*[10] have shown that Tweens and Spans are toxic to the dog. Lecithin is a popular emulsifier, but Ashby[1] has shown that purified non-toxic lecithin becomes toxic after storage for more than forty-seven days. Baer of the Banting Institute has synthesized distearoyl lecithin which we have found to be non-toxic.

All iodized oil emulsions were tested in various quantities by both stomach tube and intravenous administration.

RESULTS

Only partial success was achieved in any of the experiments with animals after placing the emulsions into the stomach by tube. Most of the results were negative. Increasing the doses only prolonged the gastric emptying time without effecting absorption or concentration in the liver or spleen. When the pylorus was relaxed by administering 1 cc. of 1 per cent procaine, either twenty minutes before or with the homogenate, intestinal absorption was not effected, usually requiring eighteen to thirty hours. Injection subcutaneously of 1 cc. representing 75 gm. of adrenal cortex did not hasten absorption.

Since Frazer claims that oil droplets of 0.5 micron are absorbed directly into the lacteals and thus bypass the liver, it was thought that this might give the spleen a better chance to trap them. Therefore, a long series of experiments were done with homogenates containing increasing concentrations of Tween-80 in order to reduce the size of the droplets. Tween-80 was used because Krantz, Culver, Carr and Jones[10] reported a low toxicity for this emulsifier. These experiments failed to show the spleen although roentgen examinations were made repeatedly up to fifty-five hours. However, we found that if a rat had been injected intravenously with an iodized oil emulsion, followed by a second dose by stomach tube within a week or so later, an excellent shadow of the spleen and liver was produced (Fig. 1). This observation led us to believe that something had remained in the spleen

from the intravenous injection which trapped the iodine given by stomach tube.

Olsson and Ekman[12] recorded occasional splenograms after oral administration of bromated sesame oil to rats. We gave rats very finely homogenized emulsions of bromiodized oils and bromiodized lecithin with various emulsifiers by stomach tube, but we obtained no better results than with the iodized oils. Bromiodized lecithin was solid and hard to homogenize. The emulsions in large doses produced diarrhea which sometimes led to death.

With so little success after intragastric use of various iodized oil emulsions, numerous attempts were made to secure good results with intravenous injections. Much work has been done already with intravenous oil emulsions for nutrition, especially by Stare and associates.[16] We obtained sharp contrast of the spleen within one hour after intravenous injection of pale iodized oil emulsions with no ill effects, as shown in a rat of Experiment 66 (Fig. 2). Pantopaque was very toxic even when mixed with iodized oil before emulsification, but the mixture produced a good opacification of the spleen. Proferrin produced a splenic shadow only after repeated injections on different days. The addition of potassium iodide did not increase the contrast. Zirconium oxide powder suspended in 7 per cent hemoglobin solution gave a good contrast of the lungs, but not of the spleen. Zirconium phosphate, silver iodide and vioform sols were found too toxic in the few experiments we did.

Since hemolysis and emulsification depend on lowering of surface tension, perhaps all emulsifiers will hemolyze erythrocytes. We have found that if intravenous injections are made slowly, the pH and osmotic pressure need not correspond with that of the blood. Since we found 7 per cent solution of hemoglobin non-toxic intravenously, we made no determination of the hemolytic activity of our emulsions. We did take pains to get particles less than 3 microns in diameter since hemogenates containing droplets or aggregates of more than

Fig. 2. This 200 gram rat was injected intravenously with 3 cc. of 25 per cent emulsion of iodized linseed oil containing 5 per cent of Tween-Span and 5 per cent glucose and roentgenographed after 1 hour 5 minutes.

6 microns in diameter clog the pulmonary capillaries. In order to achieve such small particle size, we resorted to the use of a two stage homogenizer operated at about 3,000 pounds per square inch with recirculation. Considerable heat is developed in this procedure and, if allowed to become excessive, may break the emulsion. We were not able to heat the emulsions to 100° C. for sterilization, but sufficient heat occurred in the homogenizer to reach temperatures used for milk pasteurization. The surface activity of the emulsifier parallels its bacteriostatic properties. The liberation of traces

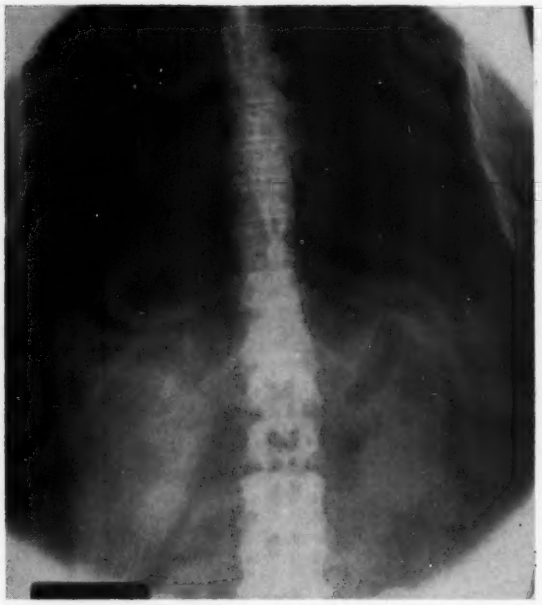

FIG. 3. Liver and spleen before emulsion was given.

of iodine would also have a bacteriostatic effect.

In humans, slight initial success was obtained with some of the emulsions and techniques tried in animals. For instance, if a patient is given 100 cc. of 1 per cent procaine and, twenty minutes later, an emul-

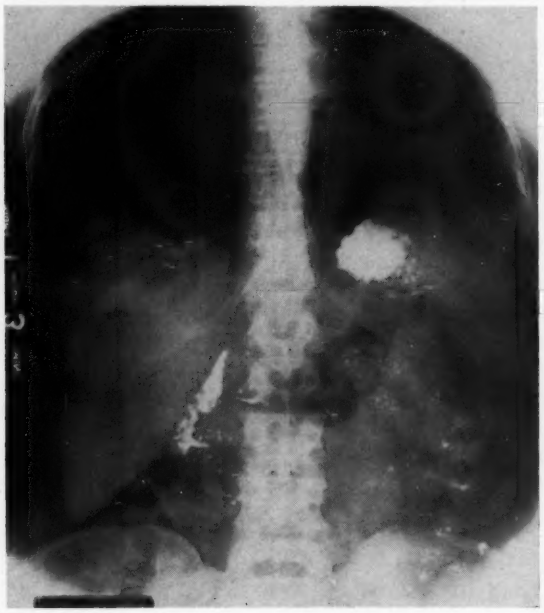

FIG. 4. Density of liver and spleen slightly increased after drinking 80 cc. emulsion of equal parts Lipiodol and Tween-80; 100 cc. of 1 per cent Procaine solution was given 20 minutes before the iodized emulsion in order to increase the rate of gastric emptying.

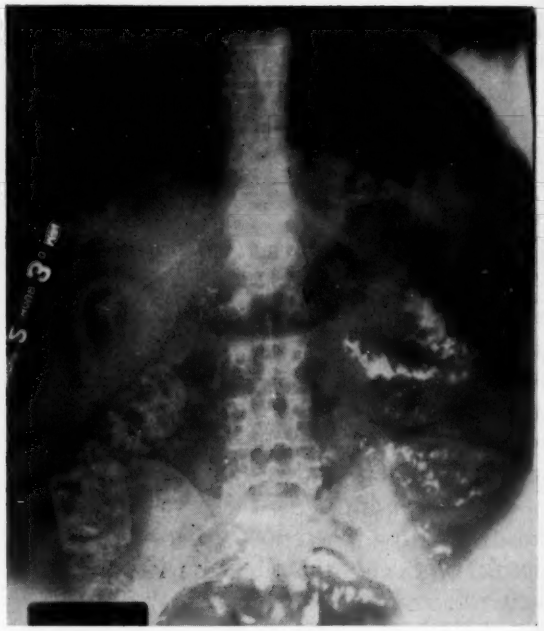

FIG. 5. At the end of 150 minutes, the emulsion is scattered in the small intestine and colon.

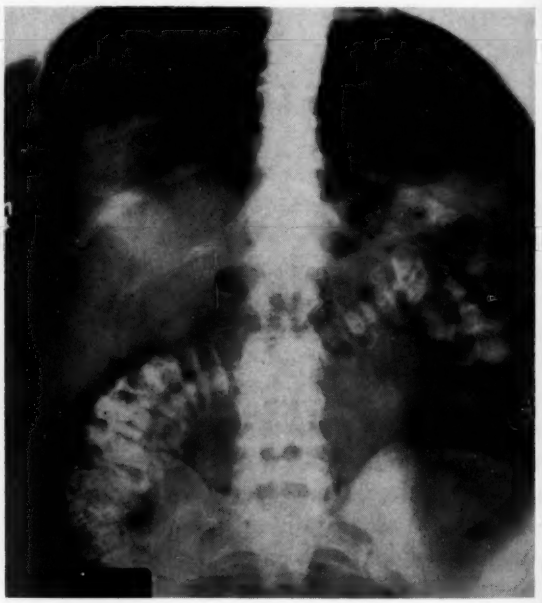

FIG. 6. At the end of 24 hours, there is retention of some emulsion in the colon. A finely mottled increased density of the liver and spleen has occurred.

sion of 20 cc. Lipiodol and 20 cc. Tween-80, this emulsion will leave the stomach more rapidly than the ordinary Lipiodol given without the preceding procaine solution. Besides faster gastric emptying, this procedure seems to favor better absorption of the emulsion since some degree of successful hepatosplenography does occur (Fig. 3–6). Most of our present experiments are proceeding in this direction in order to circumvent the systemic reactions caused by intravenous emulsions.

The best of our emulsions were stable for no longer than two months. This is an obvious defect of these preparations. Needing more observation is the length of stay of these emulsions in various organs. Beckermann, and Weyeneth and Calame[17] claim that the roentgen shadow of their emulsions disappears within twenty-four hours. Grossmann and Cooray[8] found persistence of the splenic shadow for sixty-eight hours; Keith and Briggs[9] for about a week; Rutenburg, Seligman and Fine,[15] using radioactive iodized fat, found radioactivity in the spleen for six to eight days. We interpret our results with intragastric emulsions given after previous intravenous injections as indicating retention of some part of intrasplenic emulsion for about one week.

SUMMARY

After oral administration of numerous substances, especially iodized, chloriodized and bromiodized oils, finely emulsified with various modern emulsifiers, we achieved only limited success with hepatosplenography in the rat, rabbit, and human. None of these emulsions could be recommended for use in the human, in spite of good visualization of the liver and spleen in the rat after intravenous injection. Some promise of eventual successful oral hepatosplenography is offered by our results.

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Vol. 72, No. 5

INTRAVENOUS CHOLANGIOGRAPHY AND CHOLECYSTOGRAPHY*

A NEW COMPOUND FOR ROENTGENOGRAPHY OF THE EXTRAHEPATIC BILIARY DUCTS AND GALLBLADDER

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DURING current experimental studies on hepatosplenography, a new drug was made available for clinical evaluation. This preparation, temporarily called Biligrafin and now called Cholografin, *rapidly* fills the hepatic and common ducts as well as the gallbladder after intravenous injection. Even in the absence of the gallbladder, obstruction and dilatation of the extrahepatic biliary radicles due to stone in the common duct can be demonstrated with rewarding effect.

METHOD AND RESULTS

Cholografin is the di-sodium salt of N, N′-adipyl-bis-(3-amino-2, 4, 6, triiodo)-benzoic acid and is a microcrystalline powder readily soluble in water yielding a colorless solution. The iodine content (64.32 per cent) is firmly bound in the molecule, not being split off after injection into animal or man. Since the substance is actively excreted by the liver cells, it appears in the bile within a few minutes where it may reach a concentration 30 to 100 times that of blood. No absorption occurs from the gastrointestinal tract from which major elimination takes place; only about 10 per cent or less is excreted normally by the kidneys. The intravenous LD_{50} dose for rats is 3.4 grams per kilogram of body weight and no rise in temperature occurs in rabbits tested for the pyrogenic effect of the drug.

Preparation of the patient for clinical examination is similar to that now used for cholecystography. Food, drink and tobacco are not permitted until after the completion of the studies. The water clear contrast medium is injected as a 20 per cent solution, practically isotonic with blood. Only slight irritation occurs if the tissues around a vein are injected inadvertently. Slight nausea, dizziness, trembling, sneezing or restlessness occurred after injection in only 5 of our first 60 cases. Frommhold[1] encountered nausea in only one of 200 cases and otherwise noted no side effects. Serious reaction, however, is not to be dismissed lightly especially in cases with much liver damage. Delayed chills and fever were reported by Hornykiewytsch[2] in 3 cases of unrecognized hepatic infection. Even though no definite allergic reactions have been noted so far, routine tests for hypersensitivity are suggested before giving the full dose of the contrast medium.

The full dose used by us, 40 cc., is that recommended by Gaebel and Teschendorf,[3] and this is injected slowly during a period of ten minutes. Films of the common duct and gallbladder are made at 20, 30, 40 and 120 minutes after injection. The first two films are viewed while wet in order to change exposure intervals and positioning of patient when expedient. The common and hepatic ducts usually are well seen 20 minutes after injection; the gallbladder after 60–120 minutes. A postfat meal film completes the examination.

Correct positioning of the patient is important. Both erect and recumbent examinations are made with the patient rotated 20 to 40 degrees either in the right posterior or left anterior oblique positions. Multiple films with different degrees of rotation or with the patient in the lateral decubitus position are helpful in separating overlying ribs from portions of the common duct or

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FIG. 1. After intravenous injection of Cholografin a stone is shown in lower end of a dilated common duct.

FIG. 2. Good filling of a stone-bearing gallbladder, hepatic and common ducts 90 minutes after intravenous injection of Cholografin.

gallbladder containing stones. For marked contrast, 45–50 kv. and 400–800 ma-sec. can be used.

In the presence of impaired hepatic function with or without jaundice, the common duct usually is not visualized. Instead, the compound is excreted by the kidneys in sufficient concentration to produce good urograms.

Demonstration of calculi in the common duct with this new contrast medium, especially after the gallbladder has been removed, obviously is of prime interest. The success with which this procedure can be employed is exemplified by the following case report.

FIG. 3. Urogram 30 minutes after intravenous injection of Cholografin. Gallbladder and biliary ducts are not visible indicating probable hepatic dysfunction. This female, aged forty-nine at the time of this roentgen study, had had painless jaundice for one week; icterus index was 50, cephalin flocculation plus 2 (24 hours); 3 plus (48 hours), amylase 320, bromsulphalein normal, thymol turbidity 8, bilirubin direct 12.3, total 20.8. Slow recovery occurred under medical treatment.

A forty-four year old female had a gravel-containing gallbladder removed in 1950. No stones were found in the common duct. There followed a symptom-free period until September, 1953, when intermittent epigastric pain recurred. Pancreatitis was suggested by the clinical findings, but an intravenous cholangiographic study with Cholografin revealed the presence of a stone in the common duct (Fig. 1). This was removed after choledochostomy and the patient made an uneventful recovery.

DISCUSSION

The use of this new contrast substance was first reported to the Rhenish-Westphalian Röntgen Society in Dusseldorf on May 16, 1952, by Frommhold of Berlin. His report concerned work with experimental animals followed by 250 clinical examinations in man. Gaebel and Teschendorf found this new drug useful also for routine cholecystography and this has been our own experience (Fig. 2). When the drug fails to be excreted by the liver because of dysfunction, a satisfactory outline of the common duct may not be obtainable. At the same time, evaluation of the urograms so obtained could form the basis of a good hepatic function test (Fig. 3).

SUMMARY

A new compound (Cholografin) for intravenous cholangiography and cholecystography is described. The common duct fills with this contrast material within twenty minutes so that obstructing stones can be revealed either in the presence or absence of the gallbladder. Moreover, the gallbladder also fills within 60 to 120 minutes. Impaired hepatic function causes the compound to be excreted rapidly by the kidneys and evaluation of the urograms thus obtained might serve as the basis for another good liver function test.*

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* This compound, temporarily designated Biligrafin and now called Cholografin (Schering, A. G.) and originally investigated in Germany by those mentioned in this report, was supplied to us by the Division of Clinical Research, the Squibb Institute for Medical Research, N. Y., through the courtesy of Dr. Mark H. Lund, Assistant Medical Director.

INTRAVENOUS CHOLEDOCHOLAMINAGRAPHY*

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INTRAVENOUS choledochography with cholografin is now being used to visualize the hepatic and common ducts in postcholecystectomy cases.[1,2,3] Cholografin is excreted rapidly by the liver, and the extrahepatic biliary radicles are visualized within twenty minutes, except in the presence of hyperbilirubinemia and/or lowered hepatic function. One of the prerequisites for improved visualization of the extrahepatic biliary ducts is careful technique. Despite the use of laxatives, multiple positions, low kilovoltage and high milliamperage, an occasional case will be encountered in which the diagnosis of common duct calculus will be difficult because of interference from overlying intestinal gas. This handicap can be overcome by making laminagraphic studies within 1 cm. either side of the mid-coronal plane with the patient in the supine position.

In Figure 1*A* the two calculi in the dilated common duct are not well visualized because of the surrounding intestinal gas. In the laminagram of the same case, the two calculi stand out clearly (Fig. 1*B*).

In Figure 2*A*, the common duct is faintly visible in a fifty-four year old woman who had a cholecystectomy four years previously. The overlying gas makes it difficult to exclude the presence of a calculus in the common duct, but in the laminagram the

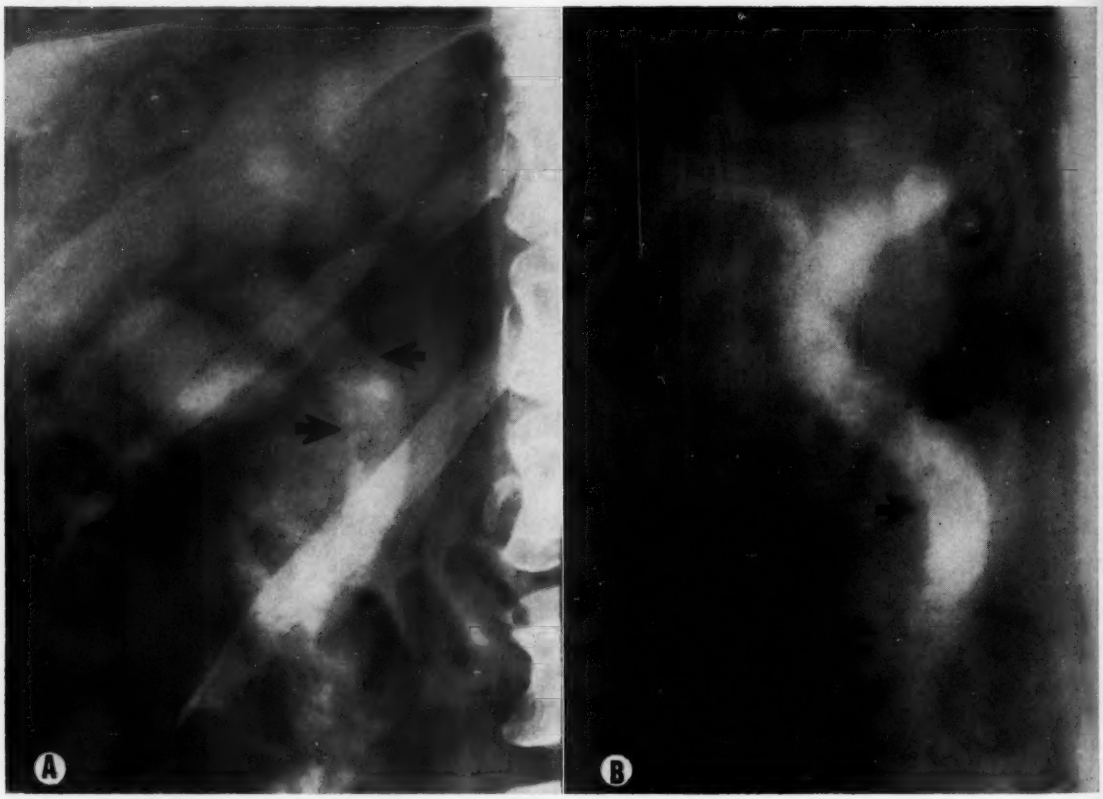

FIG. 1. (*A*) The common duct is obscured by overlying intestinal contents and gas. Questionable calculi in common duct. (*B*) Common duct calculi are now clearly visualized after laminagraphic study. Good example of main hepatic duct and its branches.

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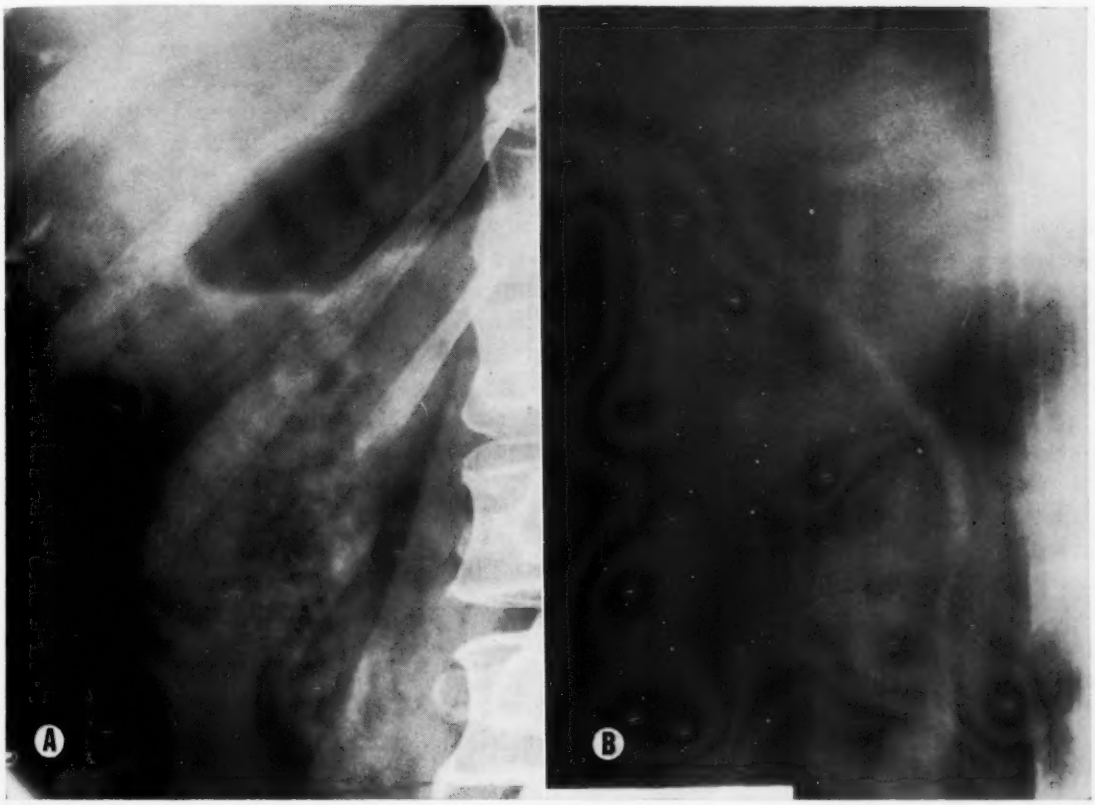

Fig. 2. (*A*) The common duct is obscured by overlying intestinal contents and gas. (*B*) A normal common duct is now clearly visualized after laminagraphic examination.

absence of stones in the common duct is confirmed (Fig. 2*B*).

Good laminagrams of the common duct may be obtained in the average case by making the exposures in the mid-coronal plane. Occasionally it is necessary, however, to make additional laminagrams 1 cm. either side of the mid-coronal plane. The results are sufficiently encouraging to warrant the combined use of intravenous choledochography and laminagraphy.

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EPITHELIOMA OF THE BUCCAL MUCOSA*

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THROUGHOUT the world there is general agreement among oncologists that cancer of the buccal mucous membrane is best treated with radium, or a combination of roentgen rays and radium. Since the advent of antibiotics making postoperative infection less fatal, some surgeons have attacked the majority of intraoral cancers with abandon. They are still hesitant, however, to operate on buccal cancer unless the lesion is very small. The facial mutilation following the surgical removal of even moderately sized cancers of the cheek discourages the majority of surgeons.

If the treatment of this disease is admittedly in the realm of the radiologist, we should consider all the techniques available and in a given case select the technique that is most likely to effect a complete cure. We may treat them entirely with radium, entirely with roentgen rays or by a combination of both.

As the lethal dose of ionizing radiations to cancer cells is, as a rule, less than the lethal dose to normal cells, one could assume that routine overdosage would always effect a cure. Every experienced radiotherapist knows this is not true. If a breakdown of the tumor bed occurs, the end result is more likely to be a regrowth of the cancer than a simple radiation ulceration. It is obvious, then, that for routinely good results in the treatment of cancer, wherever situated, the tumor bed must be preserved.

Additional evidence of the importance of the tumor bed is gained from the fact that gingival cancer, unless extremely radiosensitive, is difficult to cure. Little assistance in the control of the disease by the reaction in the tumor bed is gained as the tumor bed in this instance is chiefly composed of bone. Again cancers of thin-walled hollow organs, such as the esophagus, wherein the tumor bed is necessarily thin, are more difficult to cure than buccal cancer. With these proofs of the importance of the tumor bed, radiation therapy for buccal cancer should be designed to irradiate the tumor adequately but at the same time to preserve the tumor bed. This is most easily accomplished by taking advantage of the inverse square law. The distance of the radiant source from the surface of the tumor should be such that the tumor receives a sufficient dosage, but at the same time the tumor bed should not be hurt beyond repair.

To treat buccal cancer wholly by external irradiation is obviously inadvisable, as the tumor bed receives a greater dosage than does the tumor. In buccal cancers of over 1 cm. in thickness it is essential to deliver part of the total tumor dose from the skin surface. However with growths of this size it is impossible to have the intraoral applicator far enough removed from the surface of the growth to deliver an adequate dose to the deeper lying parts of the neoplasm from this source alone.

The most important part of the treatment of buccal cancer is intraoral irradiation. Those particularly skilled in roentgen therapy have attempted to accomplish this part of the treatment by the use of a small cone. Because of the necessary distance from the tube target to the tumor the tumor bed is overirradiated if adequate dosage is given to the tumor. A further disadvantage is listed by Quick[3] who states that, "One has only to try adjusting a set of cones to a series of oral neoplasms to realize how few can be completely and satisfactorily exposed by this means."

Radium provides the ideal modality by which adequate dosage can be delivered to the tumor without damage to the tumor bed. It may either be applied to the surface or buried in the substance of the growth. As most treatment centers have available

* From the Breed Radium Institute, Chicago, Illinois. Presented at the Fourth Inter-American Congress of Radiology, Mexico City, November, 1952.

only small amounts of radium, the surface application is difficult. For adequate dosage the weak sources must be held in position for a long time. This is accomplished by making a mold of pliable material in which the radium sources are buried. This device must be worn or held in the mouth several hours daily until the dose has been given. It is uncomfortable and traumatic, and the patient must be hospitalized during treatment.

The intratumoral technique may be carried out with radium needles or radon implants. Recently following the lead of the Manchester group, needles of low intensity have become popular. Utilizing Paterson's tables[1] for one or two plane needle implantation this method has proved to be quite successful in selected cases. This method should be particularly effective in centrally placed growths of not over 2 centimeters in diameter. It also requires hospitalization and is painful and traumatic.

The radon implant technique has its strong supporters. Quick believes it to be particularly advantageous if the growth extends backward to the angle of the jaw. In this site, it is difficult, if not impossible, to insert radium needles properly.

Although excellent results may be obtained with intratumoral techniques they are not without their dangers. One never can be sure that the needles or implants are properly placed. The needles particularly are apt to become displaced or even come out. The insertion of both needles and implants is traumatic. One who has implanted many cancers of the tongue is only too well aware that multiple cervical metastatic nodes may suddenly appear two to three months after implantation.

AUTHOR'S TECHNIQUE

A careful and gentle examination of the tumor must first be made to determine the limits and fixity of the growth. The submental, submaxillary aad cervical lymph node areas are checked for palpable nodes. Exact measurements with particular attention to the thickness are taken. A biopsy is always obtained but not until sufficient treatment has been given to kill the superficial cancer cells, and then only from this part of the growth.

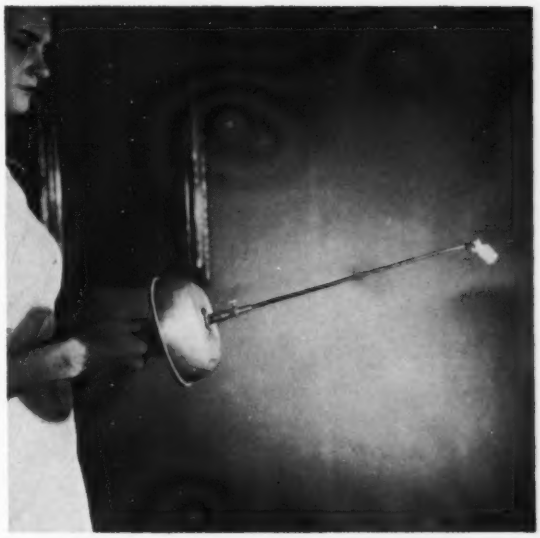

Fig. 1

Many operators believe it is essential to remove carious teeth or to use strong measures to "clean up" the mouth. With the technique about to be described the condition of the mouth is of little importance. We do believe gentle methods of oral hygiene should be followed but that operative trauma or strong drugs should not be employed as these measures may facilitate metastasis. It is impossible by whatever means to sterilize the oral cavity.

Reference is then made to Paterson's dosage charts[1] for plane surfaces considering an area extending 1 cm. beyond the edges of the tumor in all directions. A radon applicator is prepared containing from 400 to 800 millicuries of radon. The screening consists of 2 millimeters of silver and 4 mm. of rubber. One millimeter of the silver is in the silver tube surrounding the glass radon tube and 1 mm. in the silver box in which the tubes are placed. The small silver box which measures 1.5 by 2 cm. is surrounded by rubber tubing 4 mm. in thickness which composes the rubber screen and provides the proper distance of the radon from the surface of the tumor. The applicator is held by hand against the tumor by means of a long rod (Fig. 1), with the operator stand-

FIG. 2

ing behind a large lead plate 2½ inches in thickness (Fig. 2). Our radon applicator has an active surface area of 1 by 1.5 cm. and is placed successively against enough points surrounding the tumor to produce the effect of a circular applicator with the radium at the periphery. With tumors of 2 centimeters or less in diameter four points around the periphery are sufficient. With larger or irregular growths, more points are usually necessary. The applicator is held for five minutes against each point and usually two points are treated daily.

The best results are obtained if the treatments are spread over a period of three to four weeks.

THE DOSE

There is no fixed tumor dose. Reference to Paterson's graphs[2] will show that with roentgen radiation given over a period of eight days the lethal dose for squamous cell cancer will vary from 4,000 to 8,000 roentgens. That of normal tissue cells is probably about 50 to 75 per cent higher. Fortunately, in a given patient the relative sensitivity of the tumor will usually parallel the relative sensitivity of the normal tissues.

It is desirable to deliver to the tumor as great a dose as the adjacent normal tissues will tolerate. The three or four week treatment period suggested is sufficient to watch the development of the radium reaction in both the tumor and in the normal tissues. A greater dosage in gamma roentgens will be tolerated than of roentgen-ray roentgens. The increased treatment time also will permit a greater total dose than if all treatment were administered in a shorter time.

Over a period of three to four weeks it is our general plan to deliver from 5,000 to 8,000 gamma roentgens to all portions of the tumor, administering 80 per cent from the mucous membrane surface and 20 per cent from the skin surface. The ultimate dose delivered to any patient will depend upon the demonstrated sensitivity of the tumor and the normal tissues.

EXTERNAL TREATMENT

It is our policy to carry out external irradiation from the skin surface opposite the tumor with a radon applicator 4 cm. square containing about 500 mc. of radon and applied at a distance of 2 to 4 cm. These treatments also are given daily and applied concurrently with the intraoral treatments.

With the patient recumbent, a balsa wood block of the desired thickness is strapped with adhesive tape to the skin of the cheek opposite the growth. A heavy lead guard is lowered around the block and the radon placed inside the guard resting upon the wood block. Treatments usually last from thirty to forty minutes.

In general, we believe the suggested treatment for cancer of the cheek has advantages over any other method. The tumor bed is adaquately treated but not overirradiated. The correct dose for any tumor can be administered with fair accuracy. The many other advantages of the divided

dose technique are obtained. The treatment is nontraumatic. Hospitalization is not necessary, and in fact the patient is always ambulatory and may usually continue his regular work.

COMPLICATIONS

Bone Involvement. If the growth invades the mandible or maxilla, or if it involves the mucous membrane over the bone, the prognosis must be guarded. Here no assistance is gained from the tumor bed and the success or failure of radiation therapy depends entirely upon the sensitivity of the cancer cells. If after a thorough course of treatment the tumor still persists in the region of the bone, we believe radical surgery to remove the involved bone or mass offers the only hope of recovery.

Metastasis. Metastatic lymph nodes from cancer of the cheek are usually to the submaxillary, submental or cervical nodes on the side of the growth. Metastasis as a rule is a late development. It is our practice to treat palpable lymph nodes with teleradium therapy during or immediately after the course of treatment to the primary tumor. These treatments will stop the growth in the lymph nodes and, in fact, will either make them become much smaller or disappear altogether. It is our opinion that complete sterilization of proved cancerous lymph nodes is difficult with irradiation. Block dissection, however, when done by a skilled surgeon may be curative. It is useless, however, to subject the patient to a block dissection of the nodes of the neck if the primary growth is not controlled. Therefore, we keep the enlarged lymph nodes under control with teleradium therapy until we are sure the primary growth has been destroyed, and if they persist we refer the patient to the surgeon for a block dissection of the affected side of the neck.

Between the years 1930 and 1949, 52 cases of malignant disease in the mucous membrane of the cheek were treated. One case has been deleted from our calculations as it was a metastatic hypernephroma and obviously does not belong in this series. Of the 51 remaining cases 50 were squamous cell tumors and 1 a mixed cell salivary gland tumor. When this patient was admitted, the tumor measured only 1.5 cm. in diameter. Under treatment the mass disappeared only to reappear two years later. A second course of treatment again caused disappearance of the mass but again it recurred after an additional year. He then went elsewhere where surgery was employed. Complete destruction of the tumor was never accomplished and he died of his disease ten years after the growth first appeared. This case is included in our series.

We have divided our cases into two groups, favorable cases and unfavorable cases. Duration or size does not necessarily make a case favorable or unfavorable. The neoplasm may have been present for many months or it may obtain considerable size and still be considered favorable. As a general rule, the longer the disease has been present, or the larger it has become, the more difficult it will eventually be to eradicate completely. If the bone or periosteum is involved we distinctly believe these complications to be unfavorable. Metastasis also places the case in the unfavorable group. The great majority of unfavorable cases have been ill for many months with large ulcerated lesions that have spread to surrounding structures. Nearly one-third of our unfavorable cases came to us after failures with other types of treatment. Only 1 case treated previously was classified as favorable. This case had an incomplete surgical removal and was referred immediately after surgery. Of the 9 unfavorable cases with previous treatment, the former treatment was as follows: 3 with surgery alone, 2 with surgery and roentgen irradiation, 1 with roentgen irradiation alone, 1 with radium needles alone, 1 with diathermy and radium needles, and 1 with radon implants. All of these cases ultimately died of their disease.

Of our 51 cases, 44 were males and 7 females. Twenty-six patients developed their disease in the left cheek and 25 in the right. The average age of the males was 62.4 years and of the females 58.4 years. The youngest

TABLE I

AGE AND SEX

Age Group	Males		Females	
	Favorable	Unfavorable	Favorable	Unfavorable
30–34	1			
35–39	1			
40–44	1			
45–49	2	1		
50–54	2	2	1	
55–59	3	3		
60–64	3	11	2	
65–69		4	1	1
70–74	1	3		
75–79	2	1		
80+		2		
Unknown		1		2
Total	16	28	4	3

Average age—males 62.4 yr.; females 58.4 yr.

patient was 33 and the oldest 80, with the greatest number of patients coming in the 60–64 age group (Table I).

It is observed in Table II that of the 13 patients who came in within three months after the first symptoms of the disease, 5 had tumors 2 cm. in diameter or larger and that 3 had tumors that measured over 3 cm. in diameter. Thus, even tumors of short duration may have grown to considerable size.

Of significance is the fact that the duration of symptoms progressively becomes shorter throughout the years covered by this report. Between 1930 and 1934 the average duration of symptoms was 18.5 months, while from 1935 to 1939 it was 12 months; from 1940 to 1944, 8.5 months; from 1944 to 1947, 4.5 months; and from 1947 to 1949, 6.5 months. This I believe indicates that the dissemination of cancer information to the public is increasingly more effective in bringing the patient to the physician earlier.

Seventeen patients used tobacco and 7 had carious teeth that could have been considered a possible cause of the growth. Only 3 had a positive history of preexisting leucoplakia.

For convenience in localizing the tumors, the cheek was divided into an anterior, a middle and a posterior third. Fifteen tumors were confined to the middle third, 12 to the posterior third and 6 to the anterior third. Five tumors invaded both the anterior third and the middle third, and 5 the middle and posterior thirds. Eight large tumors invaded all three thirds of the cheek.

The growth either invaded the bone or involved the mucous membrane of the bone in 19 cases, the mandible alone in 13 cases, the maxilla alone in 3 cases and both the maxilla and mandible in 3 cases.

Metastases to lymph nodes were found in 6 cases. Two cases had submaxillary node involvement, 1 submental and 3 presented spread of the disease to the cervical lymph nodes.

RESULTS

Our results are summarized in Table III. Twenty cases were classified as favorable of which 16, or 80 per cent, were living and free of disease three years later. Of 42 cases which were treated prior to 1947, 17 were classified as favorable, of which 13, or 76.4 per cent, were free from disease after five years. As I have never seen a cancer of the cheek recur after three years, I believe the three year end result is as significant as the five year results.

Of the 31 cases classified as unfavorable, only 3, or 9 per cent, recovered. In the five year group of 26 unfavorable cases only 2, or 7.4 per cent, recovered. In the entire series the three year cure rate was 37.2 per cent and the five year cure rate was 35.7 per cent.

It is appreciated that few have large amounts of radon or radium at their command. However, the same results may be anticipated if cobalt 60 is used, as this source has gamma rays comparable to those of radium. This paper is presented so that those who have or will obtain suitable large sources of radium or cobalt 60 will find here recorded a technique that for many years has proved to be effective.

SUMMARY

Most oncologists agree that cancer of the buccal mucous membrane is best treated

TABLE II

DURATION AND SIZE OF LESION BY YEARS

	0–3 mo.				4–6 mo.				7–9 mo.				10–12 mo.				12–18 mo.				18–24 mo.				Over 24 mo.				Unknown			
Size cm.	1	1 to 2	2 to 3	over 3	1	1 to 2	2 to 3	over 3	1	1 to 2	2 to 3	over 3	1	1 to 2	2 to 3	over 3	1	1 to 2	2 to 3	over 3	1	1 to 2	2 to 3	over 3	1	1 to 2	2 to 3	over 3	1	1 to 2	2 to 3	over 3
1930 to 1934			1	1							2																					2
																										Average duration 18.5 months						
1935 to 1939						2	2	1							1			1					1		1				1			
																										Average duration 12 months						
1940 to 1944		2				4		3		1	1	1							1					1		1						
																										Average duration 8.5 months						
1944 to 1947	2	1		1	1	1	1																	1								
																										Average duration 4.5 months						
1948 to 1949	3		1	1						1				1		1								1*								
																										Average duration (except for recurrent case) 6.5 months						
Total	5	3	2	3	1	7	3	4		2	3	1		1		2		1		1			2	2		1		3			1	3

* Recurrence after surgery and radium.

TABLE III

RESULTS OF TREATMENT

	No.	No. Living over 3 yr. Free of Disease	Per Cent 3 yr. Cures
3 Year Favorable cases (1 treated by surgery)	20	16	80
Unfavorable cases include 9 previously treated 3 surgery alone 2 surgery and roentgen rays 1 roentgen ray alone 1 radium needles 1 radium needles and diathermy 1 radon implants	31	3	9
Total	51	19	37.2%
			Per Cent 5 yr. Cures
5 Year Favorable Unfavorable	17 25	13 2	76.4 8
Total	42	15	35.7%

with radium. Treatment should be designed to administer a cancerocidal dose to the tumor but to spare the tumor bed. The difficulties in applying surface irradiation by means of a mold or in employing intratumoral treatment either by needles or radon implants are obvious.

The author's technique consists of surface treatments of short duration, administered with a radon applicator containing from 400 to 800 millicuries of radon. Paterson's dose chart for plane surfaces is consulted and the radon applicator held by hand against several points around the periphery of the growth. Individual treatments last five minutes and one or more points are treated daily over a period of three to four weeks. External treatments from the skin surface with the radon pack at from 2 to 4 centimeter distance are carried out at the same time. As a rule, 80 per cent of the total dosage is delivered from the mucous membrane surface and 20 per cent from the skin surface.

Fifty-one cases were treated by the author from 1930 to 1949. Fifty were squamous cell epitheliomas and one was a mixed cell salivary gland tumor.

The cases were divided into two groups, favorable cases and unfavorable cases. Of twenty favorable cases, sixteen, or 80 per cent, recovered. Of thirty-one unfavorable cases, three, or 9 per cent, recovered. The five year cure rate for the entire series was 35.7 per cent and the three year cure rate 37.2 per cent.

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VOL. 72, NO. 5

MASSIVE PREOPERATIVE IRRADIATION IN THE TREATMENT OF OSTEOGENIC SARCOMA IN CHILDREN*

A PRELIMINARY REPORT

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THE treatment of osteogenic sarcoma in general and in children particularly has been discouraging. In 1938 Coley and Peterson[1] reported 23 patients from Memorial Hospital, all children, with a five year survival rate of only 8.6 per cent. As has been emphasized by Coley and Pool[2] in 1940, the prognosis of this disease in the first two decades of life is extremely poor. In addition, the peak incidence is found in these age groups. Coley and Pool[2] also obtained the impression that amputation after irradiation was possibly more beneficial in the treatment of the disease than was amputation alone. The authors just cited, however, did not separate chondrosarcoma and fibrosarcoma from true osteogenic sarcoma—undoubtedly accounting for higher survival rates in that series. Ferguson,[4] in a review of 258 amputations performed for osteogenic sarcoma contained in the Bone Sarcoma Registry, concluded that preoperative irradiation was of value. He advocated late amputation, six or more months from the onset of symptoms, combined with preoperative irradiation, as the method of choice for the treatment of the disease.

In 1929 Sugiura and Benedict,[7] investigating the Flexner-Jobling carcinoma in the rat treated with radon, found that following irradiation there was moderate protection against subsequent implantation of some types of tumor cells in these animals. Although this hypothesis was not proved, a heavily irradiated tumor might liberate substances which could conceivably confer some unknown resistance to the host, thus rendering it relatively impervious to a further invasion by the tumor. It has been estimated[5,10] that at least 6,000 roentgens must be delivered to an osteogenic sarcoma in a period of a few weeks in order to inactivate it for an extended time.

In recent reports, Tudway[8] and Shanks[6] advocate heavy preoperative irradiation of osteogenic sarcoma. They favor following irradiation by local resection if possible. However, we are of the opinion that amputation is the procedure of choice in the large majority of cases when the tumor involves an extremity.

Because of the possibility that irradiation followed by amputation might increase the survival rate of these unfortunate young patients, a program of heavy preoperative irradiation was instituted at Memorial Hospital in 1951, the findings of which at the end of two years form the basis for this preliminary report.

CLINICAL DESCRIPTION

The series includes 15 patients, all children and adolescents, with osteogenic sarcoma involving a bone of the lower extremity. The first patient was admitted to the hospital on January 29, 1951, and the last on December 31, 1952, covering an approximate two year period (Table 1).

Age and Sex. The patients ranged from seven and one-half to seventeen years in age. There were 10 females and 5 males.

Site of Involvement. The distal one-third of the femur was the site of the tumor in 7

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TABLE I

Clinical				Irradiation				Results			
Case No.	Initials	Sex and age	Bone	Tissue dose	Number of treatments	Days treated	Period from last treatment to surgery	Well	Died	Living with disease	Period from surgery until metastases detected
1	G.R.	M-10	Femur distal	6,000 r	10	13	1 day	—	19 mo.	—	18 mo.
2	S.I.	F-17	Femur distal	8,000 r	8	9	2 days	—	—	22 mo.	22 mo.
3	B.B.	F-15	Femur distal	8,000 r	6	7	1 day	—	15 mo.	—	9 mo.
4	G.A.	F-12	Tibia prox.	10,000 r	6	7	1 day	16 mo.	—	—	—
5	B.D.	F-9	Tibia prox.	10 000 r	9	12	1 day	—	—	9 mo.	9 mo.
6	C.R.	F-11	Tibia prox.	10,000 r	8	9	2 days	—	14 mo.	—	12 mo.
7	J.K.	F-7	Femur distal	10,000 r	5	6	2 days	—	10 mo.	—	3½ mo.
8	E.W.	F-10	Tibia distal	12,000 r	5	6	2 days	12 mo.	—	—	—
9	M.A.	F-9	Tibia prox.	12,000 r	8	9	2 days	—	4½ mo.	—	3 mo.
10	B.B.	F-9	Tibia prox.	10,000 r	5	5	2 days	10 mo.	—	—	—
11	E.C.	M-9	Femur distal	12,000 r	8	9	2 days	6 mo.	—	—	—
12	C.L.	M-13	Tibia prox.	12,000 r	8	9	1 day	7 mo.	—	—	—
13	C.S.	F-11	Tibia distal	12,000 r	8	9	3 days	7 mo.	—	—	—
14	L.D.	M-11	Femur distal	10,000 r	7	9	2 days	2½ mo.	—	—	—
15	M.G.	M-11	Femur distal	12,000 r	8	9	2 days	2 mo.	—	—	—

cases, the proximal one-third of the tibia in 6 cases, and the distal one-third of the tibia in 2 cases.

Biopsy. Aspiration biopsies were performed in 12 cases.[3] The diagnosis was made in 11 of these, while 1 case was inconclusive and was followed by open biopsy. Open biopsies were performed initially in 4 cases.

Diagnosis. The pathologic diagnosis was *osteogenic sarcoma* in each case following gross and microscopic study of the specimen.

Duration of Symptoms. The shortest period of symptoms prior to admission was two weeks, and the longest was nine months. The average duration of symptoms was two and one-half months.

Trauma. Several of the patients gave a history of minor trauma to the involved extremity, which we believe served merely to call their attention to a lesion already present.

Metastases. There was no clinical or roentgenographic evidence of metastasis in any of these patients before the institution of treatment.

METHOD

The irradiation was administered with a 1 mev. roentgen-ray machine. Other operating factors were: 3 ma., filter of 7.0 mm. W, 2.0 mm. Hg, and 8.0 mm. Cu; half-value layer of 3.8 mm. Pb.

Two fields were employed in each case, one anterior and one posterior, or one medial and one lateral. The field dimensions ranged from 15 cm. to 26 cm. in length in the long axis of the extremity, and from 6 cm. to 17 cm. in the coronal plane.

Tissue dosages were as follows: 6,000 r (1 case), 8,000 r (2 cases), 10,000 r (6 cases) and 12,000 r (6 cases). The period required for administration ranged from five to ten days (Table 1).

Amputation was performed in all 15 cases within one to three days after completing irradiation. Because of the massive tissue dose administered over such a short period of time, enough to destroy the limb completely, it was deemed advisable to amputate as soon as possible after completion of irradiation. Furthermore, in order to obviate the possible occurrence of undesirable and dangerous effects from the absorption of irradiated tumor products, we felt it was advisable to perform early amputation.

The portals were carefully chosen in order to allow sufficient nonirradiated skin proximally for closure of the wound. Incision through irradiated skin was meticu-

TABLE II

BLOOD AND TISSUE CHEMISTRY STUDIES

Case No.	Initials	Serum Alkaline Phosphatase (Bodansky units)				Tumor Glycerophosphatase (Bodansky units per gram)			
						Central		Peripheral	
		Pre-irradiation	During irradiation	Post-irradiation	Post-operatively	Acid	Alkaline	Acid	Alkaline
1	G.R.	—	—	5.8	5.0	—	—	—	—
2	S.I.	2.7	—	—	—	—	0.4	—	0.4
3	B.B.	7.9	—	—	—	0.5	7.5	1.0	6.1
4	G.A.	5.2	—	2.6	2.9	0.3	0.19	—	—
5	B.D.	—	8.3	6.1	5.6	0.15	2.5	0.15	4.5
6	C.R.	55.7	73.4	34.4	16.5 14.1	0.18	0.48	0.38	0.7
7	J.K.	42.0	38.3	29.4	10.2	0.09	13.0	0.45	82.0
8	E.W.	12.8 10.2	—	9.6	7.0	0.2	32.0	0.3	38.0
9	M.A.	5.2	3.7	3.2	4.8 3.2	—	—	—	—
10	B.B.	6.0	—	4.9	—	0.14	0.54	—	—
11	E.C.	8.8	—	7.3	14.8	—	0.28	—	—
12	C.L.	9.1	—	7.7	8.6	0.06	0.31	—	—
13	C.S.	13.4	15.4	—	12.5	0.14	0.07	—	—
14	L.D.	—	14.1	12.4	—	0.06	0.42	—	—
15	M.G.	26.2	14.7	14.1	7.1	0.05	0.65	0.07	0.91

lously avoided as far as possible in all cases at amputation.

SERUM AND TISSUE PHOSPHATASE (TABLE II)

It was determined by Woodard and Higinbotham[9] in 1941 and by Woodard and Coley[10] in 1947, that a phosphatase producing osteogenic sarcoma, which received a tumor dose of 3,000 r to 9,000 r delivered in two to six weeks, was affected so that its capacity to produce the enzyme was greatly diminished or completely destroyed. In this series of patients, therefore, we felt it was important to study their serum and tumor phosphatase levels in order to obtain information on the effect of massive doses of radiation upon this aspect of tumor metabolism.

Of 53 untreated osteogenic sarcomas in which the tissue alkaline phosphatase was determined in this institution, only 35, or 66 per cent, contained more than 2 units per gram, or significantly more than the normal bones of growing children. Therefore, unless the serum alkaline phosphatase of a patient with osteogenic sarcoma was definitely elevated prior to treatment, or more than 2 Bodansky units per gram was detected in the tumor tissue, there was no proof that the tumor originally contained sufficient enzyme so that a loss due to irradiation could be demonstrated. In the present series, Cases 4, 9, 10, 11, 12, 13 and 14 were not shown to have high phosphatase tumors, and so were excluded from consideration of enzyme changes.

Of the patients who showed evidence of having high phosphatase tumors, the most interesting is Case 6. The initial serum phosphatase was high, 55.7 units per 100 cc., and increased to 73.4 units per 100 cc. during irradiation, a change which was probably significant. The serum phosphatase decreased slightly at the completion of irradiation, and reached the upper limit of normal for an eleven year old child one week after amputation. Only small amounts of alkaline phosphatase were detected in the tumors. These changes can be explained

on the assumption that the production of alkaline phosphatase by the tumor ceased during irradiation, and therefore little was detected in the tumor. At the same time, the changes in the tumor produced by irradiation resulted in the liberation of such large amounts of pre-formed phosphatase that the capacity of the liver to excrete the enzyme was temporarily exceeded, with resulting accumulation in the blood. The circulation was not cleared until two weeks after the start of irradiation. The changes in Case 15 were very similar to those in Case 6, but less marked.

The tumor tissue of Cases 3, 5, 7 and 8 contained moderate to large amounts of alkaline phosphatase. Data on the serum of these patients either were incomplete or there was some diminution in the serum alkaline phosphatase during irradiation and after amputation. It is presumed that, in these patients, insufficient time had elapsed for the pre-formed enzyme in the tumor to be "flushed out," although the possibility cannot be excluded that alkaline phosphatase was still being produced in their heavily irradiated tumors.

DISCUSSION

Low thigh amputations were performed in all cases in which the tibia was the site of involvement. Of the 7 cases in whom the tumor originated in the distal end of the femur, 5 were subjected to high thigh amputation. Hip joint disarticulation was performed in the remaining 2 (Cases 14 and 15) for two reasons. Primarily, we have found in studying the amputated specimens that frequently the tumor extends proximally through the marrow cavity for a considerable distance, which might increase the likelihood of local recurrence if a low amputation were performed. Secondarily, the irradiation portals can be larger, still leaving adequate viable nonirradiated skin for closure. When a high thigh or subtrochanteric amputation is performed, we believe it advisable to secure smears from the marrow cavity of the femur on the specimen side at the site of amputation, obtain immediate microscopic examination, and if malignant cells are detected, a hip joint disarticulation should be carried out at once. There has been no instance of local stump recurrence in any patient in the series to date.

Systemic and local effects might be reasonably expected in patients receiving radiation doses of this magnitude even though delivered to small localized areas of the total body mass. Nausea and vomiting in this series were noted in only 2 of the 13 patients. Weakness or fatigue was not encountered in any of these cases. The complaints as enumerated are not uncommonly encountered in large volume irradiation. Erythema of mild to moderate degree was the rule, being observed in 8 of 13 cases. It was usually noted by the fourth day of treatment. In no instance was bleb formation or other evidence of more severe tissue reaction observed.

Hematologic data were not fully recorded in 7 cases; in the remaining 8 no deviation was noted from pretreatment values. In 1 case the leukocyte count fell from 13,000 to 3,000 cells per cu. mm., which can be reasonably attributed to the effects of the irradiation. No shift of the differential count was noted in any instance.

Delayed wound healing resulted in 2 patients following amputation; however, in neither was the slough severe nor did infection occur, while convalescence was not appreciably delayed. Undoubtedly, irradiated tissue had been included with the proximal skin flaps in these 2 cases at the fringe of the portals. This experience has prompted us to make tattoo marks at the upper levels of the treatment portals, so that in the operating room the surgeon can make the skin incision at least 2 cm. proximal to this mark. No other complications during or following surgery were noted in the series.

Pathologic study of the amputated specimens was carried out in all cases. The tumor from Case 10 was described as showing changes consistent with irradiation damage. Nevertheless, normal appearing tumor cells remained in abundance. It is our opin-

ion that the tumor is functionally destroyed, as far as its growth potential is concerned, by the amount of radiation delivered. Because of the short course of irradiation administered followed by early amputation, in one to three days, it is postulated that changes simply had not become microscopically evident.

To the authors' knowledge, no series of cases of osteogenic sarcoma in children treated with amputation alone has been reported with which we can compare the early survival rate in those cases and the present series treated with irradiation and amputation.

At the end of the two year period, during which we have been carrying on the treatment as described, 3 patients are alive with no evidence of disease. These are Cases 4, 8 and 10. The longest survival following surgery is sixteen months (Case 4), and the shortest is ten months (Case 10). The remaining 7 patients treated during the first two years are considered failures, 5 having died of the disease, while 2 are living with generalized metastases.

The most recently treated patients, Cases 11, 12, 13, 14 and 15, are all well with no evidence of disease from two to seven months after surgery.

Of the 5 cases who died, pulmonary metastases became clinically evident eighteen months following amputation in Case 1, nine months in Case 3, twelve months in Case 6, three months in Case 7, and three months in Case 9. Of those living with disease, Case 2 first showed clinical evidence of metastases twenty-two months following amputation, and Case 5, nine months postoperatively. These findings bear out previous impressions that a considerable period may elapse before metastases occur or become clinically manifest in this type of bone sarcoma.

It is our opinion that the results to date are not encouraging. Of the 10 patients treated during the first two year period, only 3 are considered free of disease at the end of one year, which is truly a poor survival rate in this short interval. As the more recent cases are followed, this early impression may require revision. At present, however, we do not believe that the treatment as described is increasing the survival rate of osteogenic sarcoma in childhood and adolescence; however, the series is at present too small and the period of observation since treatment too brief to permit any final conclusions as to the possible benefit of this method of treatment.

SUMMARY

1. A series of fifteen children and adolescents with osteogenic sarcoma involving a long bone of an extremity is presented.

2. A new method of treatment has been described consisting of massive roentgen irradiation over a short period followed by early amputation one to three days later.

3. Blood and tissue chemistry changes incidental to this treatment, with clinical and postoperative observations have been described.

4. No serious complications attended the irradiation itself or postoperatively.

5. At the end of two years, ten cases have been followed one year or more. Of these, three are living free of clinically detectable disease, two are living with metastases, and five are dead.

6. This study is being continued. Although early results have been discouraging, the series is too small and the period of observation too brief for final conclusions to be drawn at this time.

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ENERGY DISTRIBUTION IN THE THORAX DURING MULTIPLE FIELD AND ROTATIONAL THERAPY*†

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AT THE present time with increasing utilization in this country of multiple port technique, particularly of the Dobbie-Demy type, and with the commencing adoption in several centers, of rotation therapy, it becomes of interest and importance to know the energy distribution throughout the entire thorax during both types of therapy. This is particularly of concern to the Radiotherapy Service in this hospital since, after treating approximately a dozen bronchogenic malignancies by the multiple field method, it has been the impression that both lungs receive intensive radiation and suffer considerable damage while the tumor is receiving a cancerocidal dose. Thus, it would be of value to know how much radiation the center and adjacent parts of the involved lung are receiving, how much the opposite nonaffected lung suffers, how much is being delivered to the mediastinum, and how much the adjacent and distant skin fields are receiving while an adequate tumor dose is being administered. In the case of rotation therapy there are already many data, particularly for the center of a phantom. Of interest, however, would be the energy distribution in the case of a typical, eccentrically placed tumor in the thorax. Furthermore, it would be of interest to know what differences exist in isodose distribution between carefully administered multiple field therapy and pure rotation therapy.

In an effort to answer some of these questions, both multiple field and rotational irradiation were used on a plywood phantom of the general size and shape of the human thorax.

Most phantom experiments are performed on material of as close to unit density as possible in order to simulate body conditions. However, it was soon appreciated that a roentgen-ray beam traversing aerated lung tissue undergoes a different degree of absorption and "scatter" than in solid body substance. Up to the present, provision for this difference in rate of absorption with its consequent modification in depth dose appears not always to have been taken into account in work done on the thorax. Depth doses for a beam traversing considerable lung tissue are still often calculated from isodose charts based on experiments with a solid phantom of unit density. Quimby,[4] nevertheless, in work done on a cadaver preserved in formalin, derived a quite complete range of corrections to be used in irradiation of the chest. Paterson[3] specifically mentions and uses this correction factor in his chapters on irradiation of the chest.

Density of lung tissue in contrast to the unit density of solid parts of the body has been variously estimated at from 0.2* to 0.78.† In the thorax this situation is complicated by the fact that the beam must pass twice through some 3 cm. of solid chest wall, and, possibly, a varying amount of solid tumor substance and mediastinum, in addition to traversing a varying amount of lung parenchyma. In multiple field therapy there is an ever varying interplay of these factors.

The phantom used in the present work was of 0.5 density. This, of course, does not represent the exact situation found in a

* Personal communication from the Massachusetts Institute of Technology. Because of this low estimate of lung density, the cavities (representing thoracic cavities) in the presdwood phantom on which their supervoltage rotational therapy studies have been performed, are merely air filled.

† See the article by Failla.[1]

* Reviewed in the Veterans Administration and published with the approval of the Chief Medical Director. The statements and conclusions published by the authors are the result of their own study and do not necessarily reflect the opinion or policy of the Veterans Administration.

† Presented at the Fifty-second Annual Meeting, American Roentgen Ray Society, Washington, D. C., Sept. 25–28, 1951.

FIG. 1. Lateral roentgenogram of the calf's thorax with the thimble chamber in place.

thorax. It would, however, seem more closely to approximate actual conditions than a solid phantom of density of 1.0. In effect, it would seem to represent an averaging of the low density of aerated lung parenchyma and the more or less unit density of chest wall, tumor and mediastinum. That absorption in the plywood phantom parallels absorption in the human thorax and consequently justifies its use is apparently supported by the following two experiments.

FIG. 2. Anteroposterior roentgenogram of the calf's thorax with the thimble chamber lying between right lung and mediastinum.

In the first, the absorption was measured at different depths inside a fresh calf's thorax. Failla[1] has shown beef tissue to be almost identical to human tissue in its capacity for absorption of roentgen rays; hence use of a calf's thorax was justified from this point of view. The thorax was placed in the erect position and a Victoreen thimble chamber was maintained successively in the following locations:

(1) Just medial to the chest wall nearer the tube.
(2) Midway between chest wall and mediastinum within the nearer lung.
(3) Between the nearer lung and mediastinum (see Fig. 1 and 2).
(4) On the opposite side of the mediastinum.
(5) Between the parietal surface of the opposite lung and the chest wall.

The tip of the thimble chamber was fixed as closely as possible in the central axis of the beam. This was checked by roentgenograms. The factors, distance, and exposure time were, of course, identical to those used on the phan-

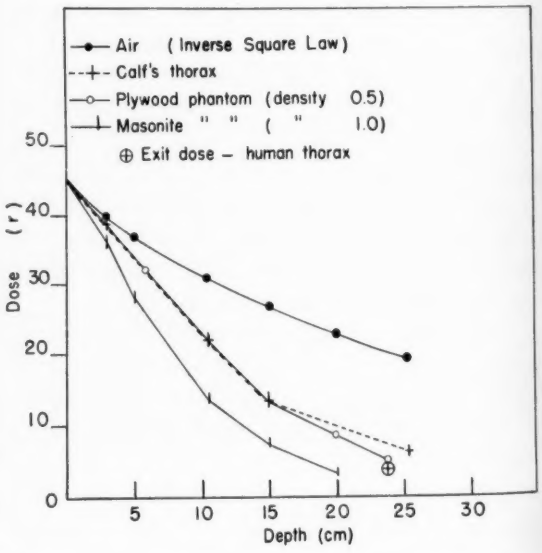

FIG. 3. A graph comparing absorption in phantoms of density 1.0, 0.5, in calf's thorax, in air (inverse square law) and human thorax (exit dose only).

Table I

Depth Material (cm.)	Calf's Thorax	Plywood (d=0.5)	Masonite (d=1.0)	Air (calc.)	Patient
0	45.0	45.1	45	45	
3	38.5		36.5	40	
5			28.3	37.2	
6		32.1			
10.5	22.3		14.4	31.3	
15	13.9	13.4	7.9	26.6	
20		8.7	3.7	23.0	
24		4.8			4.3
25	6.5				

tom. The results, compared with the readings in the plywood phantom, are recorded in Table 1 and depicted in the graph (Fig. 3).

The second trial made to justify the use of the plywood as material for a phantom of the thorax was the comparison of the exit dose through the phantom with the exit dose through the thorax of an actual patient whose thorax happened to be of identical depth as the phantom. Readings in the case of the patient were made through a vertical 7 by 15 cm. port which was so located over the right thorax that it traversed only chest wall and lung parenchyma and was lateral to the mediastinum. For this comparison both phantom and patient were irradiated with identical factors, in the same recumbent position, through 7 by 15 cm. ports and for the same period. Table II shows the comparison numerically.

Of course, comparison of exit doses does not give the entire picture since the degree of absorption at various depths in phantom and human thorax may differ in spite of agreement in exit doses. However, since an anteroposterior section through the thorax in the right mammary line, apart from the anterior and posterior chest wall, involves only homogeneous lung parenchyma, the likelihood of considerable variation of the beam at various depths is not great.

PROCEDURE

Throughout this study, both for multiple field and rotation therapy, the factors used were: 250 kv.; 15 ma.; 1 mm. Cu plus 1 mm. Al as filter; 50 cm. target skin distance; half-value layer, 1.5 mm. Cu. The machine

Table II

COMPARISON OF EXIT DOSE THROUGH HUMAN THORAX AND THROUGH PLYWOOD PHANTOM

	Depth	Exit Dose
Human thorax	24 cm.	4.3 r (average reading)
Phantom	24 cm.	4.8 r (average reading)

calibration was 40.6 roentgens per minute.

The phantom, formed approximately like a human thorax, was made of layers of $\frac{3}{4}$ inch plywood. The arrangement is shown in Figure 4. The holes, shown in Figure 5, are for the insertion of Victoreen thimble chambers. The holes were so drilled that the tips of the thimble chambers all

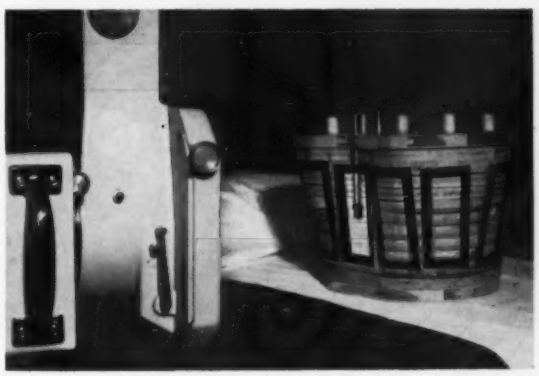

Fig. 4. The plywood phantom, with the multiple fields outlined, in position for irradiation. The light beam localizer is directed at the phantom and the light beam outlines one of the ports. Two thimble chambers are in place, one measuring the skin dose at point *g*, the other at the point of convergence of all the beams.

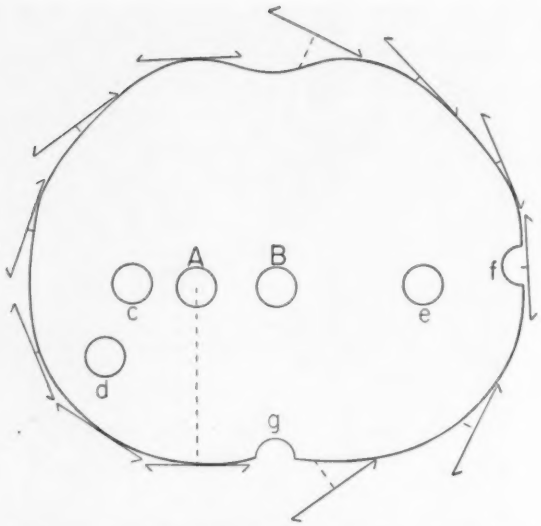

FIG. 5. A cross-section of the phantom at the level of the tips of the thimble chambers. *A* represents the average "tumor center" 5 cm. from the midline; *B*, the center of the mediastinum; *c* and *e* mark the approximate center of each lung. Twelve ports are outlined, all converging on *A*.

lay in the same transverse plane. They were placed at points corresponding to:

(1) The average center of a bronchogenic malignancy—5 cm. lateral to the midline (*A*).

(2) The center of the mediastinum (*B*).

(3) Two points well within the involved lung (*c* and *d*).

(4) The center of the noninvolved lung (*e*).

TABLE III

MULTIPLE FIELD THERAPY—12 PORTS

Exposure received by the seven various positions in the phantom in terms of the dose to the focus of the beams (tumor center)

Point Measured	A	B	C	D	E	F	G
Tumor at *A*—per cent	100	75	92	66	33	32	39
Tumor at *B*—per cent	79	100	54	42	49	39	45

(5) The skin of the posterior thorax in the midline (*g*).

(6) The skin of the lateral thorax, on the side opposite the lesion, in the mid-axillary line (*f*).

All readings were made with the phantom in the erect position.

MULTIPLE FIELD THERAPY

For multiple field therapy, twelve 7×15 cm. fields were outlined around the thorax (Fig. 4 and 5). Each was treated for unit time (one minute). Separate series of readings were made. In the one series, the central axis of each of the beams passed through the center of the mediastinum (Point *B* in the phantom); in the other, the convergence was on a point (Point *A* in the phantom) 5 cm. lateral to the center of the mediastinum, the approximate center of many bronchogenic neoplasms.

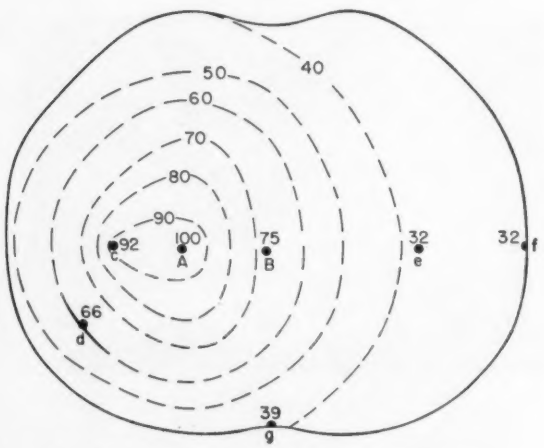

FIG. 6. Isodose curves showing the approximate energy distribution with twelve ports, the beams all converging on *A*. The lung on the involved side suffers heavily.

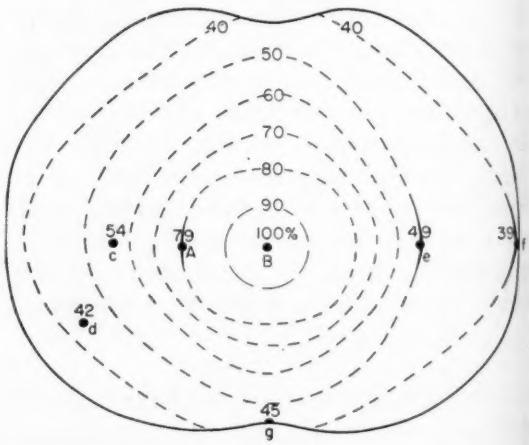

FIG. 7. Isodose curves. Twelve ports. Point *B* as tumor center. Both mid-lung regions receive a considerable exposure.

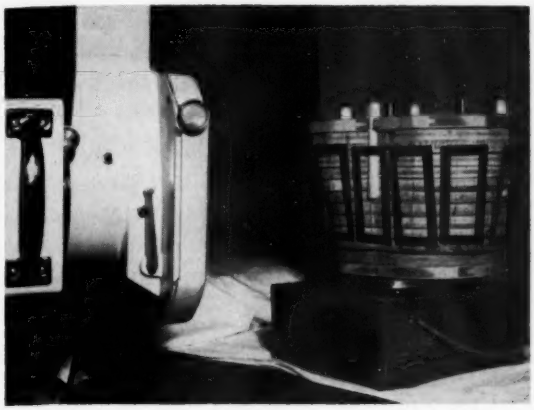

Fig. 8. The plywood phantom on a turntable for rotational therapy. The center of the beam is constantly directed at the thimble chamber at Point *A*, this point being the center of rotation.

In each of these series, exposures were measured at the focus as well as at each of the other six positions. Thus it was possible to calculate the exposure received at each of these positions when a cancerocidal dose was administered to the tumor center. This information is given in Table III.

From these tabular values, approximate isodose curves were drawn as shown in Figures 6 and 7.

ROTATION THERAPY

Following the investigation of the energy distribution in the thorax by multiple field irradiation, the phantom was set on a motor driven turntable making one revolution in approximately 100 seconds (Fig. 8).

The central axis of the beam passed through the center (*B*) of the mediastinum for one set of measurements. A second set was taken with the focus at the average tumor center (location at *A* in the phantom). Readings were taken at the focus of irradiation (Point *A* or Point *B*) and at each of the other six positions listed above. The relative energies received at each point are listed in Table IV. These results in the form of isodose charts are shown in Figures 9 and 10.

Table IV

ROTATION THERAPY. ONE ROTATION IN 100 SECONDS

Dose to the various points in terms of the exposure to the center of rotation (tumor center)

Point Measured	A	B	C	D	E	F	G
Tumor at *A*— per cent	100	68	88	56	30	23	41
Tumor at *B*— per cent	80	100	47	38	43	35	48

DISCUSSION

From this work it will be seen that, in multiple field therapy with twelve ports, to give a tumor dose of 6,000 r at *A* involves giving 5,520 r to the center of the affected

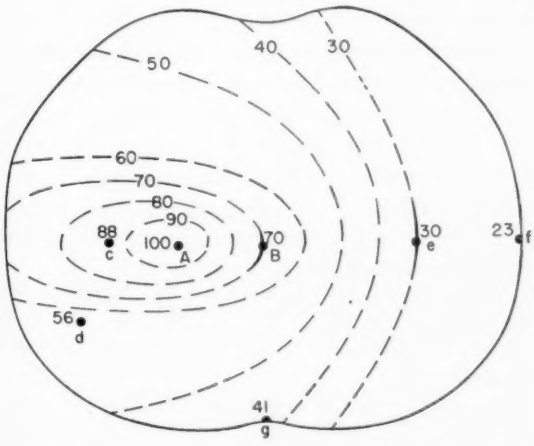

Fig. 9. Isodose curves. Rotation therapy. Point *A* is the center of rotation. Again the involved lung suffers heavily.

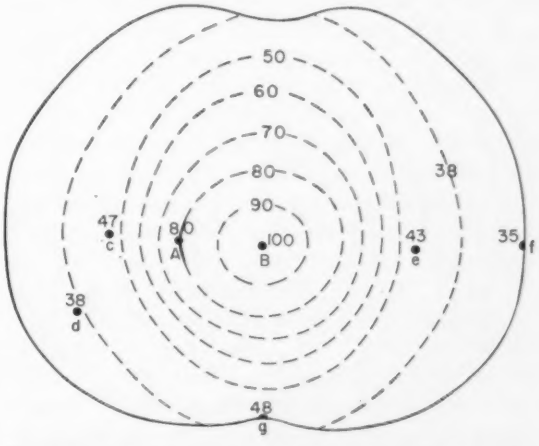

Fig. 10. Isodose curves. Rotation therapy. Point *B* is the center of rotation. Both mid-lung regions sustain heavy exposure.

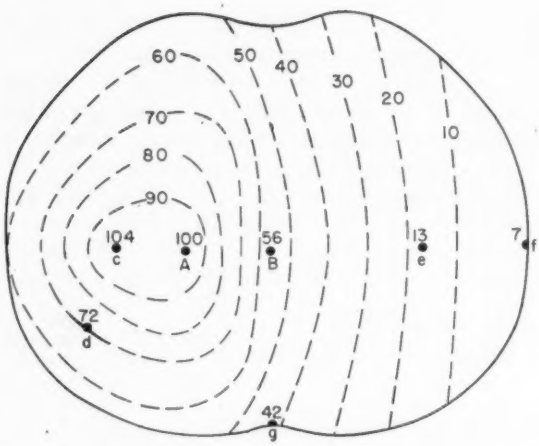

Fig. 11. Isodose energy distribution in unilateral multiple field therapy. Eight unilateral fields, all directed at Point *A*. The involved lung suffers to the maximum extent. This arrangement, however, spares the opposite lung to the greatest extent.

lung and 1,920 r to the center of the opposite lung. When 6,000 r is given to a point at the center of the mediastinum, the center of each lung receives between 3,240 and 2,940 r. That such doses are heavy and damaging, especially to lung parenchyma, is evident.

In a previous article on multiple field therapy,[2] it was shown in all cases treated by multiple fields around the entire thorax that, when a cancerocidal dose was delivered to the center of the tumor, the lungs

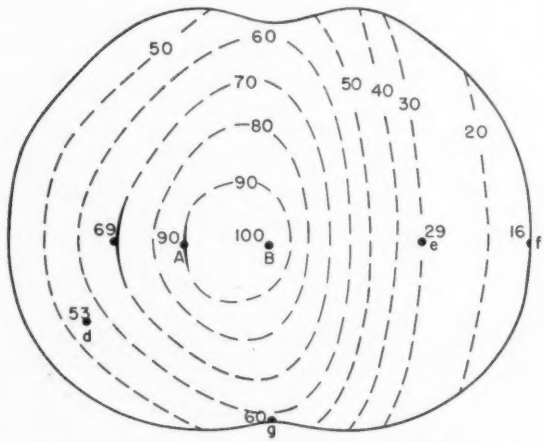

Fig. 12. Isodose curves. Eight unilateral fields. Point *B* represents the tumor center. The involved lung suffers heavily; the opposite lung is relatively spared.

received very heavy incidental irradiation which resulted in extensive pneumonitis, fibrosis and, usually, in the death of the patient. The tentative conclusion was reached that, in order to spare one lung, it might be wiser to treat unilaterally through approximately seven ports. It was thought that, while the affected lung would thus be subjected to an intense and damaging crossfire, the opposite lung would be relatively unharmed.

With the data at hand from irradiation of this phantom, it is now possible to estimate the energy distribution throughout the thorax when a cancerocidal dose is delivered to an eccentric tumor center (Point *A*) through only eight ports. It is possible to appreciate to what extent the opposite lung would escape the intensity of radiation as well as to see how much additional radiation the involved hemithorax would have to sustain. These results are shown in Table v which is to be compared with Table iii; they are also shown in isodose curves (Fig. 11 and 12).

To an eccentric tumor center at *A*, the delivery of 6,000 r involves the delivery of 6,240 r to the center of the ipsilateral lung. The opposite lung center, however, receives only 780 r. If the center of the mediastinum at *B* is the point of convergence of the eight beams, then for 6,000 r to *B* the center of one lung receives 4,140 r, the other, 1,740 r.

The comparison of the isodose distribution in the three forms of therapy, namely,

Table V

MULTIPLE FIELD THERAPY—8 PORTS

Exposure received by the seven various positions in the phantom in terms of the dose to the focus of the beams (tumor center)

Point Measured	A	B	C	D	E	F	G
Tumor at *A*— per cent	100	56	104	72	14 12*	7	42
Tumor at *B*— per cent	90	100	69	53	29	16	58

* Reading repeated at subsequent occasion.

Table VI

COMPARISON OF MULTIPLE FIELD WITH ROTATION THERAPY

Point Measured	A	B	C	D	E	F	G
Tumor at *A* (per cent)							
Multiple field	100	75	92	66	33 32*	32	39
Rotation therapy	100	68 71*	88	56	30	23	41
Tumor at *B* (per cent)							
Multiple field	79	100	54	42	49	39	45
Rotation therapy	80	100	47	38	43	35	48

* Reading repeated at subsequent occasion.

multiple field around the entire thorax, multiple field unilaterally with eight ports, and pure rotation, all directed at the eccentric tumor center (Point *A*), shows that the noninvolved lung is most spared by the unilateral arrangement. It thus receives only 13 per cent, while with the other arrangements respectively it receives 32 per cent and 30 per cent. This is accomplished, however, at a certain price; the center of the ipsilateral lung receives an exceedingly heavy dose, estimated in this study at 104 per cent.

The comparison of the results of multiple field with rotational therapy, as shown in Table VI, demonstrate that the multiple field energies are approximately of the same magnitude as the energies received at the same points treated by the rotation method. The per cent of disparity is not considered significant in view of the 5–8 per cent variation of the thimble chamber readings. Thus, the major advantages of pure rotation over multiple field therapy in the 200–250 kv. range lie in the ease and convenience of delivery but not in the isodose distribution.

SUMMARY

(1) Experimental evidence is adduced to demonstrate that a plywood phantom used in this study gave a fair approximation of the roentgen-ray absorption occurring in the human thorax.

(2) Utilizing this phantom, it is shown that when multiple field therapy is practiced around the entire thorax (twelve ports) both lung fields suffer high incidental orders of roentgen-ray exposure.

(3) Rotation therapy closely parallels multiple field therapy in roentgen-ray energy distribution throughout the thorax.

(4) Unilateral multiple field therapy (eight ports) represents the means of sparing the opposite lung to the greatest extent.

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DISCUSSION

Dr. Edith H. Quimby, New York, N. Y. Dr. Nahon has given us quite a few things to think about in this presentation. In the last few years, as radiologists have become more and more conscious that they must think in terms of tumor dose rather than in terms of air or skin dose, they have become correspondingly conscious of the fact that dosage data obtained from homogeneous, unit density phantoms may not in many cases represent the condition inside the patient where the situation is complicated by bones and air spaces, and they would like to have some means of approximating the true situation.

As Dr. Nahon said, a few years ago—quite a number of years ago now—Dr. Copeland and Mr. Woods and I undertook a comparative study of the radiation distribution within a cadaver and within a water phantom. This was pursued under grave difficulties; we had to use a therapy machine, and therefore we had to work at night, working for a short period each

time, and we couldn't get the sort of comprehensive data that Dr. Nahon has presented.

We found that within a pelvis, the effect of bones on dosage distribution was not very important, but that within the chest, after a depth of 3 or 4 centimeters, there was a progressive difference between the unit density phantom and the actual cadaver. As Dr. Nahon said, we published some curves which, unfortunately, have not been very widely used—or perhaps I should say "fortunately" since, in view of the data presented today, they are not too accurate.

It would be expected that the values Dr. Nahon got in fresh tissue would present a wider divergence from unit density material than ours did. His approach to the problem was extremely ingenious and I think he should be congratulated for thinking about it. It is a matter of considerable interest to know that a 0.5 density plywood phantom will take the place of lung tissue to a good extent. I am sure that we will all be glad to have his published data and to devise correction curves or correction tables for our own chest problems, because these are some of the hardest with which we have to deal.

When it comes to the matter of distribution of radiation from different series of techniques, it has been a very good thing for us to look at the isodose charts which were presented. Too often we think only of the dose to the tumor. We focus two or five or twelve fields on the tumor and pile up tumor dose and we don't look at the distribution throughout the rest of the tissues. Dr. Nahon is a little horrified at the fact that tissues fairly close to the tumor get big doses. Perhaps we should all be horrified, but I am afraid this can't be helped. There isn't as yet any method of pinpointing on the tumor, but if we realize this and realize that we can, by proper arrangement of fields, save a good deal of important tissue, it is certainly worth our while.

The information is, of course, not complete. (It is very difficult to get a complete set of depth dose information.) It would be expected that the twelve field technique would approximate rotation therapy. It would be expected that six field technique on one lung would approximate an oscillation through half of the cycle, 180 degrees, and the only important question in view of which of these is better, I think is, Which can more accurately be delivered? Is it easier to give rotation or semi-rotation therapy, or is it easier and more accurate to set up a lot of fields? This, each one of us will have to decide for himself.

As I said at first, this paper should give us a good deal to think about; we should all appreciate the information that Dr. Nahon has brought us.

Dr. Robert R. Newell, San Francisco, Calif. I think this is extremely important because we now see that we must amend our notions about rotation therapy, if we thought that by this technique we can irradiate selectively a nice little round area in the middle of the body. The region outside of that is also irradiated somewhat and it is going to be a nuisance.

For the primary irradiation, the proposition is very simple. [Drawing at blackboard] Consider any surface enclosing part of the body with the heavily irradiated tumor in the middle. The radiation has to go in through that surface and it is spread over its area. If it is rotation therapy it uses all of that area. The intensity of the irradiation, that is, the dosage rate, therefore, is larger, the smaller the circle—*i.e.*, the closer to the heavily irradiated central tumor. The two-dimensional case (surface of cylinder) is more nearly true than a three-dimensional case (surface of sphere) so that you see that in rotation therapy a fairly even radiation through the center is possible, but from there on out the fall-off of dose is as the radius—and that doesn't mean a very rapid fall-off.

This is modified by the fact that we are in a scattering medium, and Langmuir has shown that escape of radiation from a scattering medium doesn't fall off in the three-dimensional case as the inverse square. It falls off less rapidly than that. It piles up toward the outside and then falls off more rapidly again. This means that even in rotation therapy, we have spreading of the dose in large quantity outside of the region that we are trying to irradiate.

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THE EFFECT OF CORTATE AND OF DRAMAMINE ON A SELECTED GROUP OF PATIENTS UNDERGOING DEEP ROENTGEN THERAPY FOR CARCINOMA OF THE CERVIX UTERI*†

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MINNEAPOLIS, MINNESOTA

IN A previous communication,[4] the authors have stressed the desirability of studying clinical radiation sickness in a group of patients who are receiving approximately the same amount and quality of radiation, delivered over approximately the same period of time, to the same area of the body. It was felt that consideration of a relatively homogeneous group of this sort would eliminate, at least to a degree, the multitude of extraneous factors that crop up in attempting to evaluate as subjective a thing as radiation sickness.

Patients undergoing external irradiation for carcinoma of the cervix uteri at the University of Minnesota Hospitals constitute a relatively homogeneous group of the type alluded to above. These patients were hospitalized throughout their entire treatment period. They all received between 3,000 and 3,500 roentgens delivered to the center of the pelvis, over a period approximating twenty-eight days. The same quality of radiation was employed in all instances (400 kv., peak, 5 ma., Thoreaus filter 0.44 mm. Sn plus 0.25 mm. Cu; half-value layer 3.9 mm. Cu).

In their previous study of this group,[4] the authors found that adrenal reserve, as denoted by a modified Thorn ACTH-eosinophil response test,[5,6] was at first normal, but fell to levels considerably below normal at the end of ten to fourteen days. Continued irradiation beyond this period did not prevent a gradual return of this index towards normal. The same study showed that the basal absolute eosinophil count in these patients, after a slight initial drop, rose to abnormally high levels with continued therapy, reaching its high point at twenty to twenty-four days. An index of the severity of radiation sickness, computed daily for each patient in a uniform manner,* showed changes which roughly paralleled those of the eosinophil count for the group as a whole. When the group was broken down into premenopausal and postmenopausal patients, it was noted that the premenopausal patients tended to show a relatively flat symptom index curve throughout their course of therapy, while the postmenopausal group showed the rise in the symptom index curve noted for the group as a whole, but of a more pronounced degree. These findings are illustrated by the data presented in Charts and Graphs I, II and III.

Having the above data as a baseline, it was decided to study the effects of several of the drugs used in the treatment of radiation sickness on a group, similar, in all respects, to the group used for the baseline study. Cortate and dramamine were the drugs selected. The former was selected to determine whether or not the curve of adrenal reserve would be altered. The latter—dramamine—was chosen because it belongs to the "antihistaminic" family of drugs, and a possible effect on the eosinophil curve was considered. Both drugs have been shown to favorably effect the symptoms of radiation sickness.[1,2,3]

In most cases, the drug was administered

* Each patient was questioned daily by the same interrogator, who rated from 1 to 3 plus, seven possible symptoms of radiation sickness. These were totaled for the daily index.

* From the Department of Radiology, Division of Radiation Therapy, University of Minnesota Medical School, Minneapolis, Minnesota.

† Supported in part by the Atomic Energy Commission Contract AT-(11-1)-232.

Control: All cases

Days	0-4	5-9	10-14	15-19	20-24	25-29	30-34	
Absolute Eosinophil Count	24	19	18	21	19	20	8	Number of determinations
	197	*151*	*227*	*344*	*687*	*458*	*234*	*Average cells / cu. mm.*
Thorn Test	21	20	19	19	18	19	7	Number of determinations
	62	*39*	*21*	*32*	*41*	*46*	*51*	*Average % fall*
Symptons	41	63	44	66	65	62	12	Number of determinations
	95	*83*	*89*	*206*	*300*	*306*	*275*	*Average symptom index*

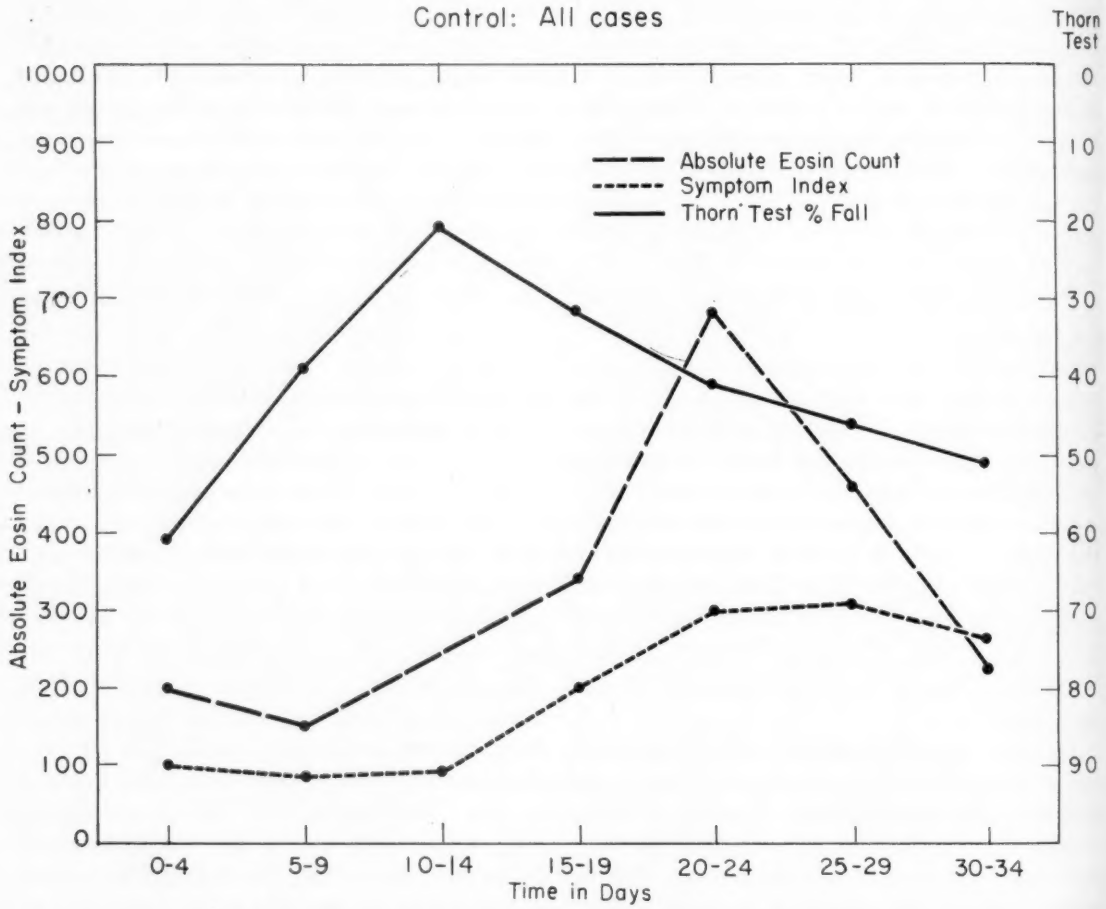

CHART and GRAPH 1. Control Group. Variations of adrenal cortical reserve (measured by a modified Thorn test), absolute eosinophil count, and symptom index in the course of roentgen therapy. The first two factors were determined from a study of 40 patients undergoing irradiation of the pelvis, and the last factor (symptom index) was determined on the last 20 patients of this group.

on the tenth through the thirteenth day of treatment, and again on the twenty-first and twenty-second days. In a few instances, the drug had to be given a day earlier, or a day later, than the anticipated schedule. In the case of the cortate group, 5 mg. of the drug was administered intramuscularly on each of the days mentioned above. The

Control : Post-menopausal

Days	0-4	5-9	10-14	15-19	20-24	25-29	30-34	
Absolute Eosinophil Count	14	13	12	13	16	11	6	Number of determinations
	177	*128*	*200*	*281*	*660*	*457*	*183*	*Average cells/cu. mm.*
Thorn Test	12	12	11	11	15	11	5	Number of determinations
	59	*51*	*16*	*24*	*41*	*40*	*46*	*Average % fall*
Symptoms	26	44	34	44	47	43	9	Number of determinations
	104	*116*	*109*	*280*	*368*	*379*	*322*	*Average symptom index*

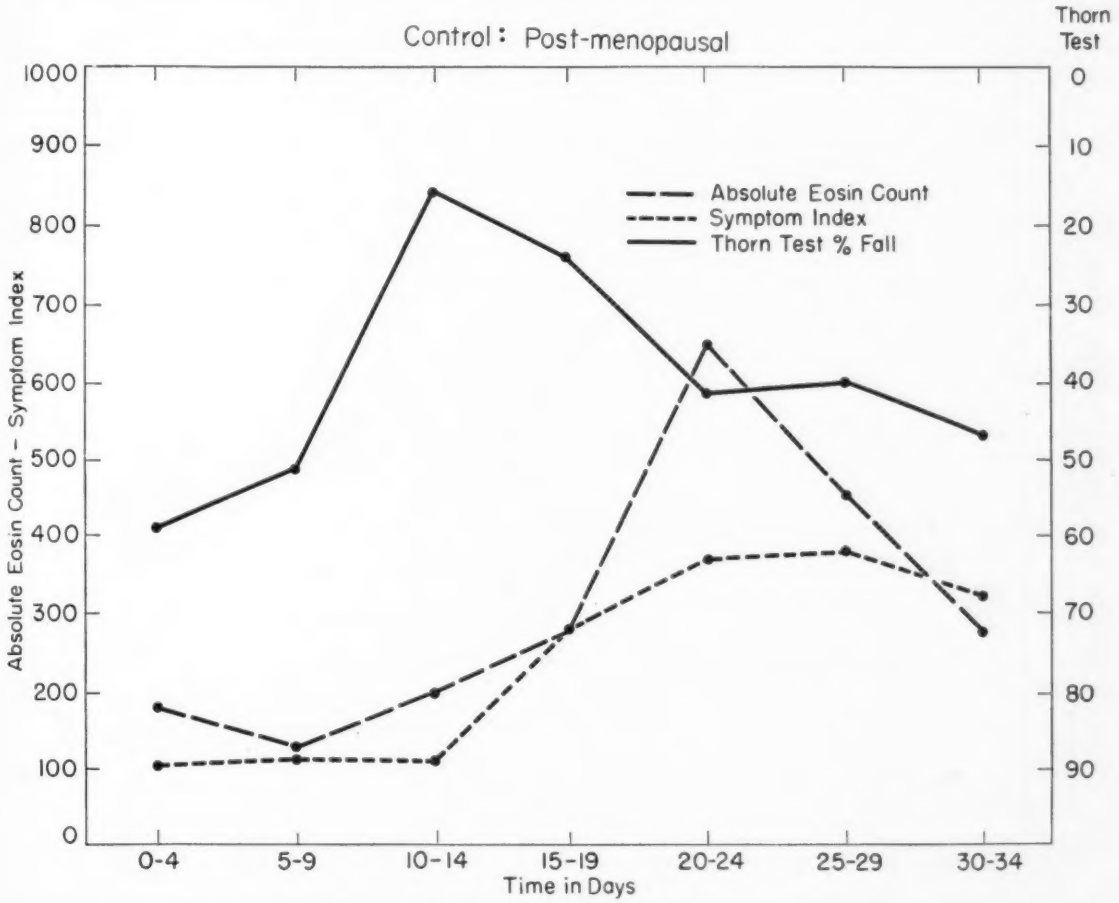

Chart and Graph II. Patients from control group who fall into postmenopausal category.

dramamine patients received 50 mg. orally, t.i.d., on each of the days mentioned.

The time periods for administration of the drugs were chosen simply in an attempt to determine what, if any, effect would be seen on the peaks of the adrenal reserve curves and eosinophil curves occurring at about these periods for the group as a whole. The dosage of the drugs was selected on the basis of their pharmaceutical efficiency, as derived from a perusal of the literature. No claim is advanced that the schedule selected is the optimum one.

Fifteen patients were studied with each

Control · Pre-menopausal

Days	0-4	5-9	10-14	15-19	20-24	25-29	30-34	
Absolute Eosinophil Count	8	5	6	7	3	8	2	Number of determinations
	246	*224*	*226*	*437*	*832*	*493*	*386*	*Average cells/cu. mm.*
Thorn Test	8	5	7	7	3	8	2	Number of determinations
	64	*28*	*23*	*42*	*41*	*54*	*64*	*Average % fall*
Symptoms	13	17	12	22	18	18	3	Number of determinations
	92	*6*	*8*	*59*	*122*	*122*	*133*	*Average symptom index*

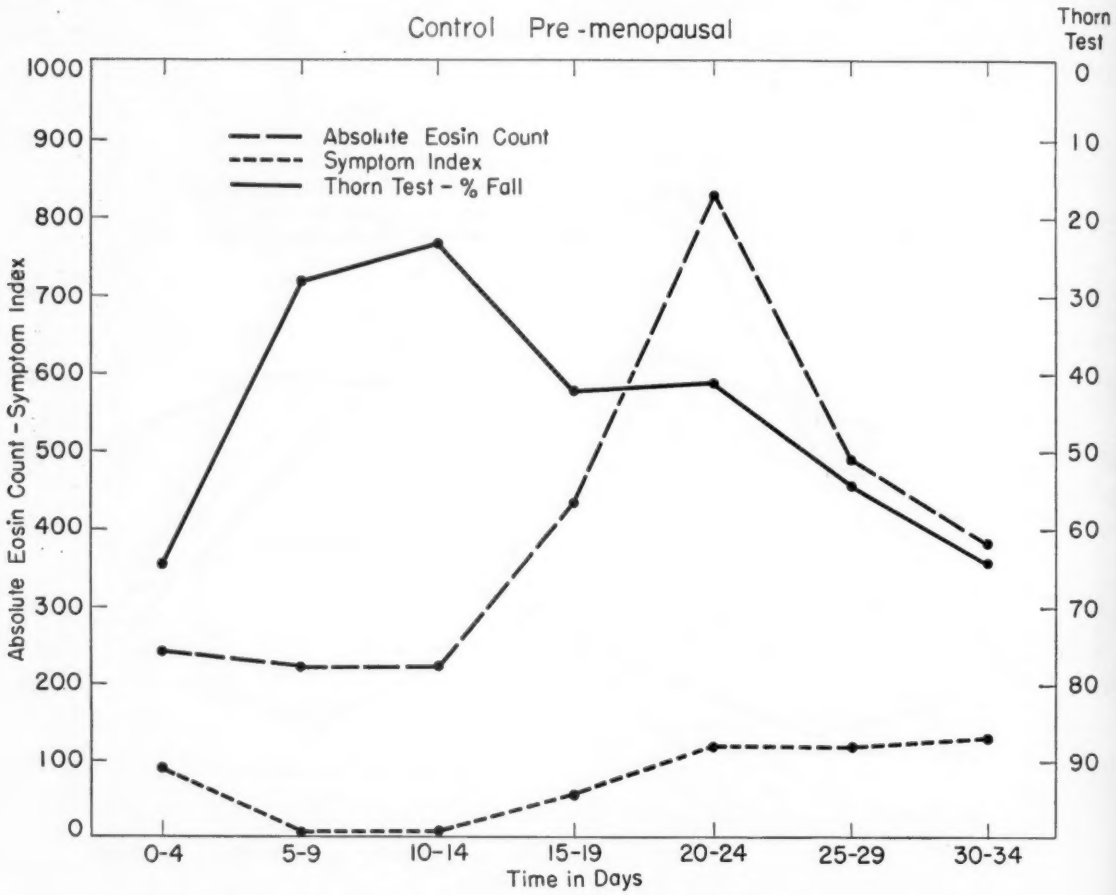

CHART and GRAPH III. Patients from control group who fall into premenopausal category.

drug. The results for each group as a whole are noted in Charts and Graphs IV and VII.

Considering the entire dramamine group first (Table and Graph IV), it was found that the change in the status of adrenal reserve, as denoted by the Thorn test, was almost identical to that noted in the control group. The main difference lies in the fact that the mean initial values in the dramamine group (prior to any drug therapy) were higher than those in the control group, although the amount and direction of the changes is such that the two curves are almost identical. Since it is the amount and direction of change of the curves,

Dramamine : All cases

Days	0-4	5-9	10-14	15-19	20-24	25-29	30-34	
Absolute Eosinophil Count	7	9	14	12	8	12	4	Number of determinations
	153	*246*	*221*	*290*	*448*	*398*	*424*	*Average cells/cu.mm.*
Thorn Test	6	9	14	11	7	10	4	Number of determinations
	76	*53*	*41*	*57*	*58*	*64*	*65*	*Average % fall*
Symptoms	23	53	51	50	49	52	12	Number of determinations
	152	*153*	*151*	*172*	*249*	*225*	*225*	*Average symptom index*

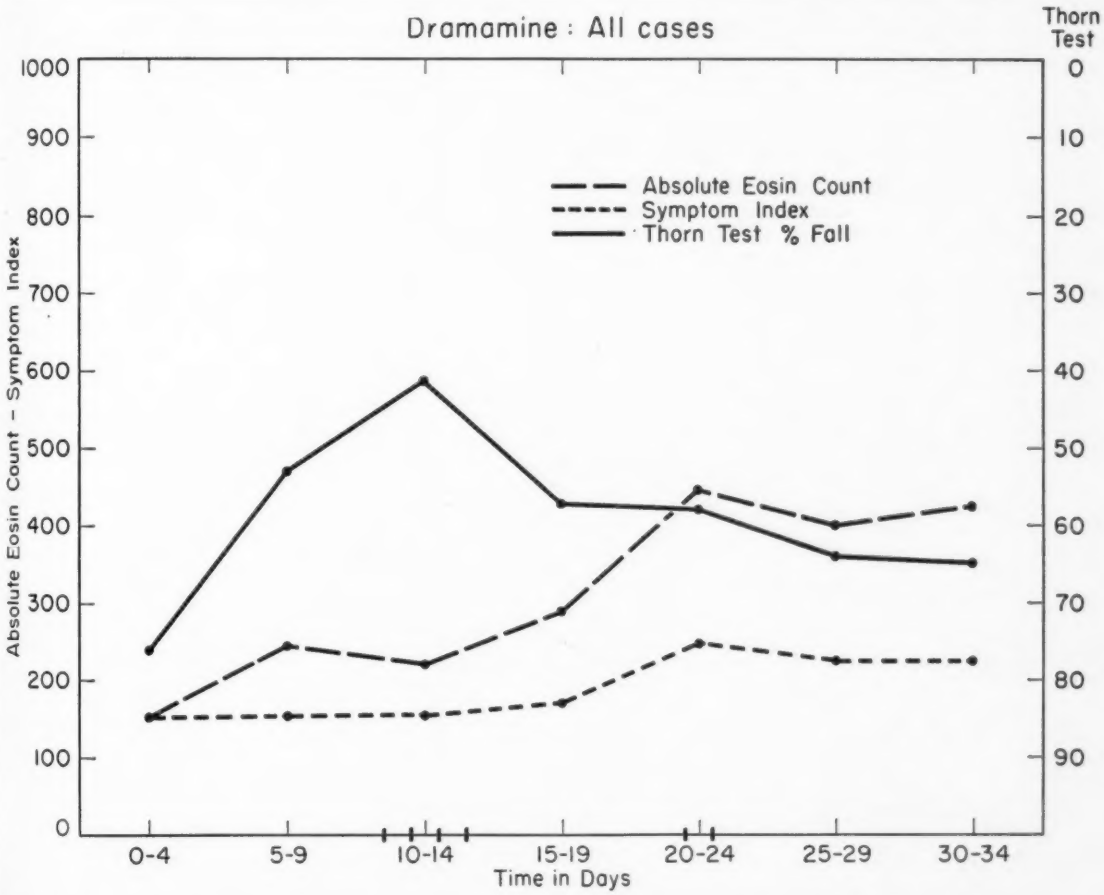

Chart and Graph iv. Dramamine Group. Patients were in all respects similar to control group except for administration of dramamine according to schedule noted in text (15 cases).

rather than arbitrary absolute values that interest us, it must be assumed that the drug, as administered, caused no recognizable alteration in the pattern of adrenal reserve.

The eosinophil curve in the dramamine cases showed, in general, the same direction of change with each subsequent time period as did the control group. The average values for the dramamine group, however, were lower with each subsequent time period (except the last) after the initial administration of the drug, than the controls. The most marked difference was

Dramamine : Post - menopausal

Days	0-4	5-9	10-14	15-19	20-24	25-29	30-34	
Absolute Eosinophil Count	5	3	6	7	4	5	2	Number of determinations
	163	*101*	*172*	*279*	*552*	*549*	*366*	*Average cells/cu.mm.*
Thorn Test	5	3	6	6	4	4	2	Number of determinations
	78	*72*	*52*	*55*	*58*	*76*	*65*	*Average % fall*
Symptoms	14	22	22	25	25	23	8	Number of determinations
	114	*186*	*236*	*204*	*340*	*383*	*275*	*Average symptom index*

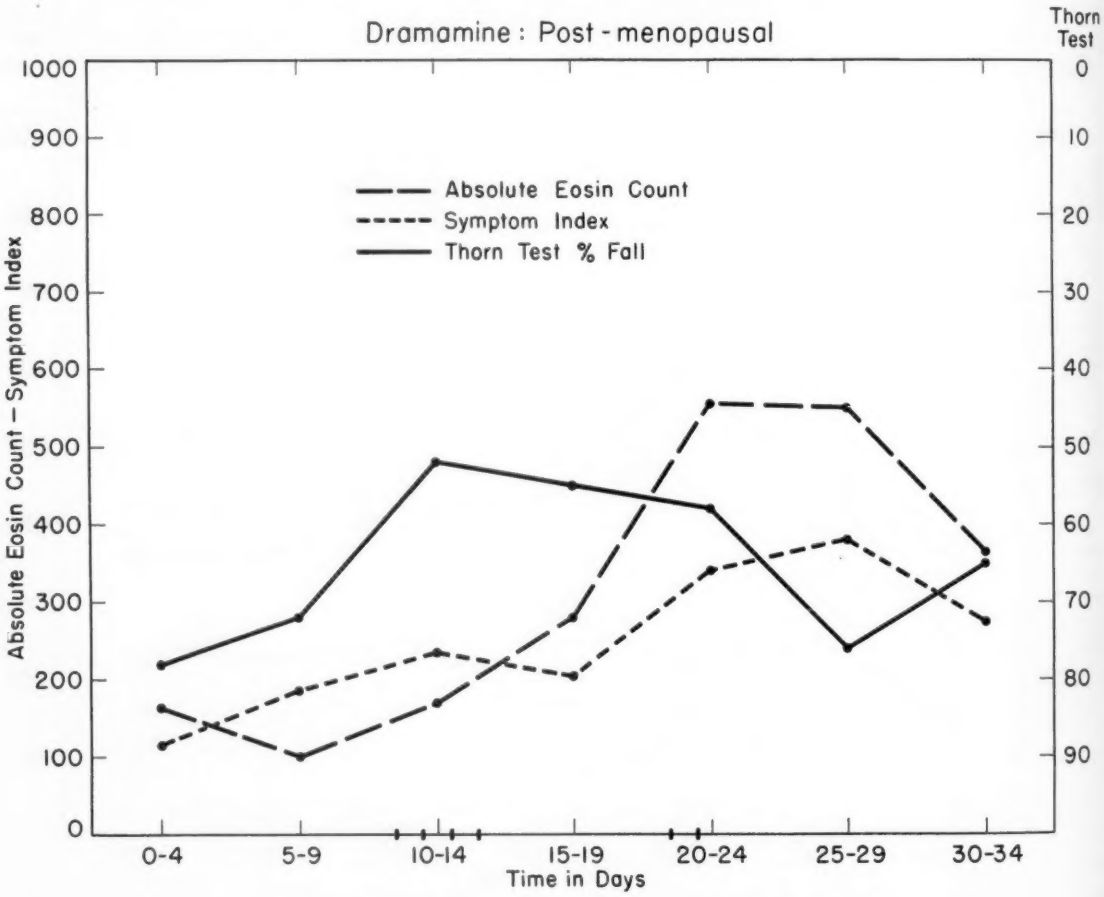

CHART and GRAPH v. Postmenopausal patients of dramamine group.

noted with the peak value of each curve at the twenty to twenty-four day interval. Here, the mean absolute count for the dramamine group was 448 cells per cu. mm. as against 687 cells per cu. mm. for the control group. The smaller number of cases in the dramamine group, however, may have influenced the results.

Comparison of the symptom index curves for the dramamine and control groups shows no recognizable alteration in the form of the curve for the dramamine group. The index is slightly higher than the controls in the early phases of treatment and becomes

Dramamine : Pre-menopausal

Days	0-4	5-9	10-14	15-19	20-24	25-29	30-34	
Absolute Eosinophil Count	2	6	8	5	4	6	2	Number of determinations
	127	*318*	*258*	*306*	*345*	*339*	*482*	*Average cells/cu.mm.*
Thorn Test	1	6	8	5	3	6	2	Number of determinations
	64	*44*	*32*	*59*	*59*	*57*	*65*	*Average % fall*
Symptoms	9	31	29	23	24	29	4	Number of determinations
	211	*119*	*86*	*135*	*133*	*100*	*125*	*Average symptom index*

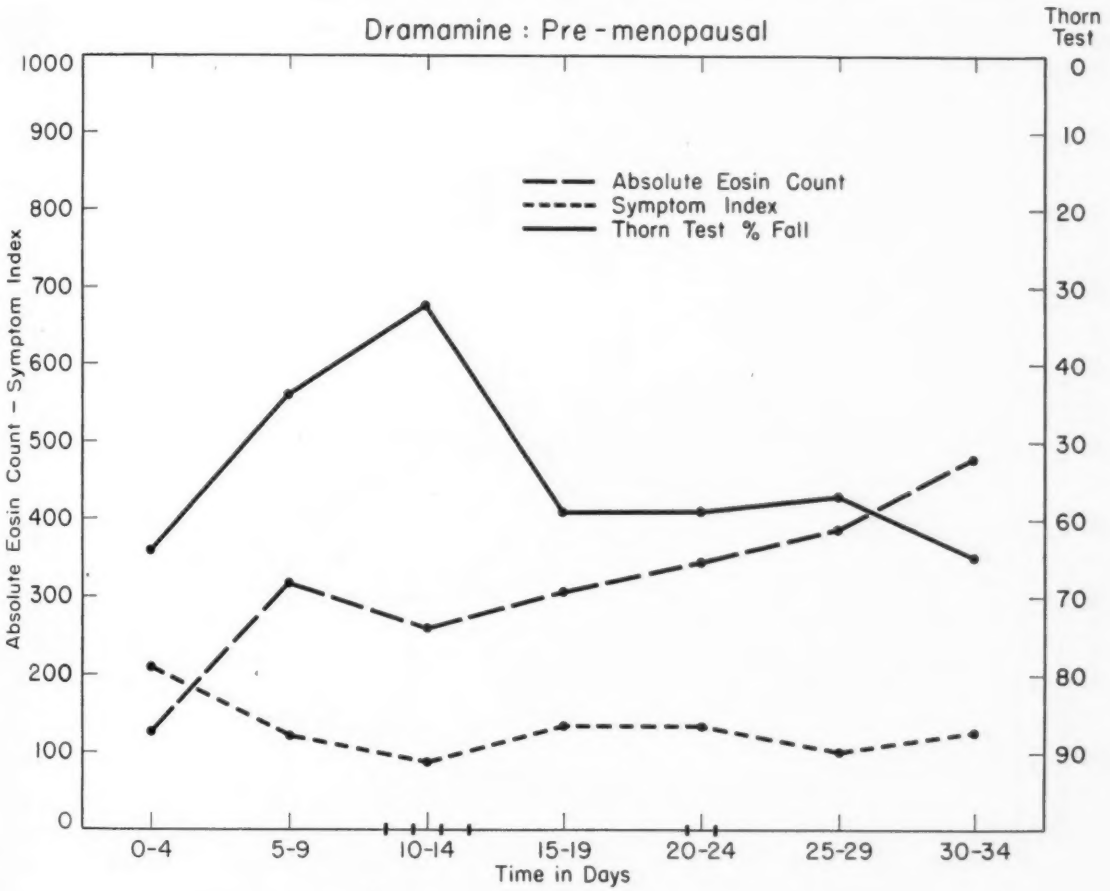

Chart and Graph vi. Premenopausal patients of dramamine group.

slightly lower toward the end, but the direction and degree of change appear quite similar in the two groups.

If the patients treated with dramamine are divided into premenopausal and postmenopausal groups,* it is noted that the postmenopausal dramamine group show approximately the same changes over the course of treatment in the three factors under study as do the postmenopausal control group, although there is slight flatten-

* Patients having had their last menstrual periods six months or more prior to the present study are considered "postmenopausal." All others are considered "premenopausal."

Cortate All cases

Days	0-4	5-9	10-14	15-19	20-24	25-29	30-34	
Absolute Eosinophil Count	12	9	8	13	12	6	2	Number of determinations
	227	*208*	*307*	*507*	*482*	*381*	*233*	*Average cells / cu. mm.*
Thorn Test	12	9	7	12	11	4	2	Number of determinations
	71	*49*	*46*	*51*	*47*	*69*	*57*	*Average % fall*
Symptoms	31	51	43	53	53	34	11	Number of determinations
	97	*57*	*58*	*70*	*106*	*232*	*209*	*Average symptom index*

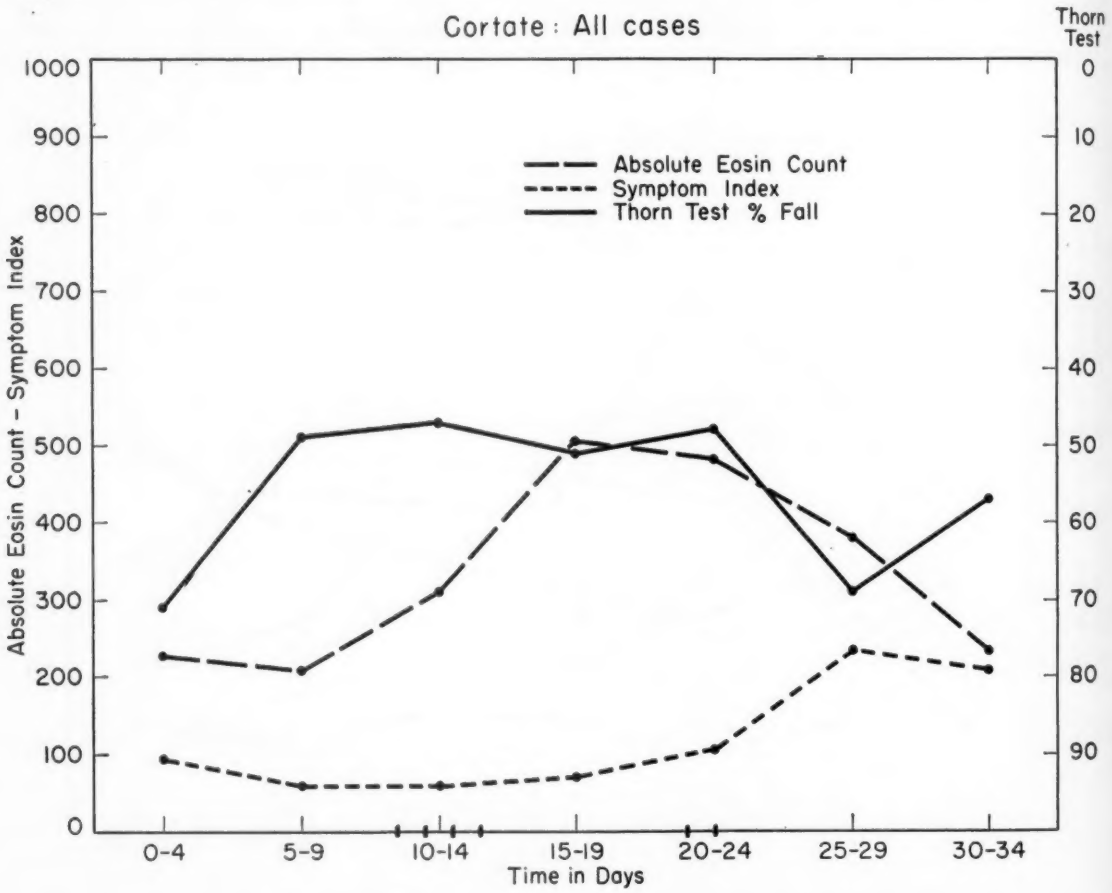

CHART and GRAPH VII. Cortate Group. Patients were in all respects similar to control group except for administration of cortate according to schedule noted in text (15 cases).

ing of all the curves compared to the control group (Charts and Graphs II and V).

The premenopausal dramamine group likewise shows little difference from the control premenopausal group except for definite flattening of the eosinophil curve (Charts and Graphs III and VI). It is noteworthy that the difference in the symptom curves noted between the control premenopausal and postmenopausal groups is dupli-

Cortate : Post-menopausal

Days	0-4	5-9	10-14	15-19	20-24	25-29	30-34	
Absolute Eosinophil Count	6	4	3	6	6	3	1	Number of determinations
	272	*309*	*305*	*467*	*594*	*444*	*103*	*Average cells/cu. mm.*
Thorn Test	6	4	2	6	6	2	1	Number of determinations
	78	*58*	*49*	*51*	*58*	*65*	*67*	*Average % fall*
Symptoms	12	25	20	23	30	15	5	Number of determinations
	75	*40*	*115*	*135*	*170*	*460*	*460*	*Average symptom index*

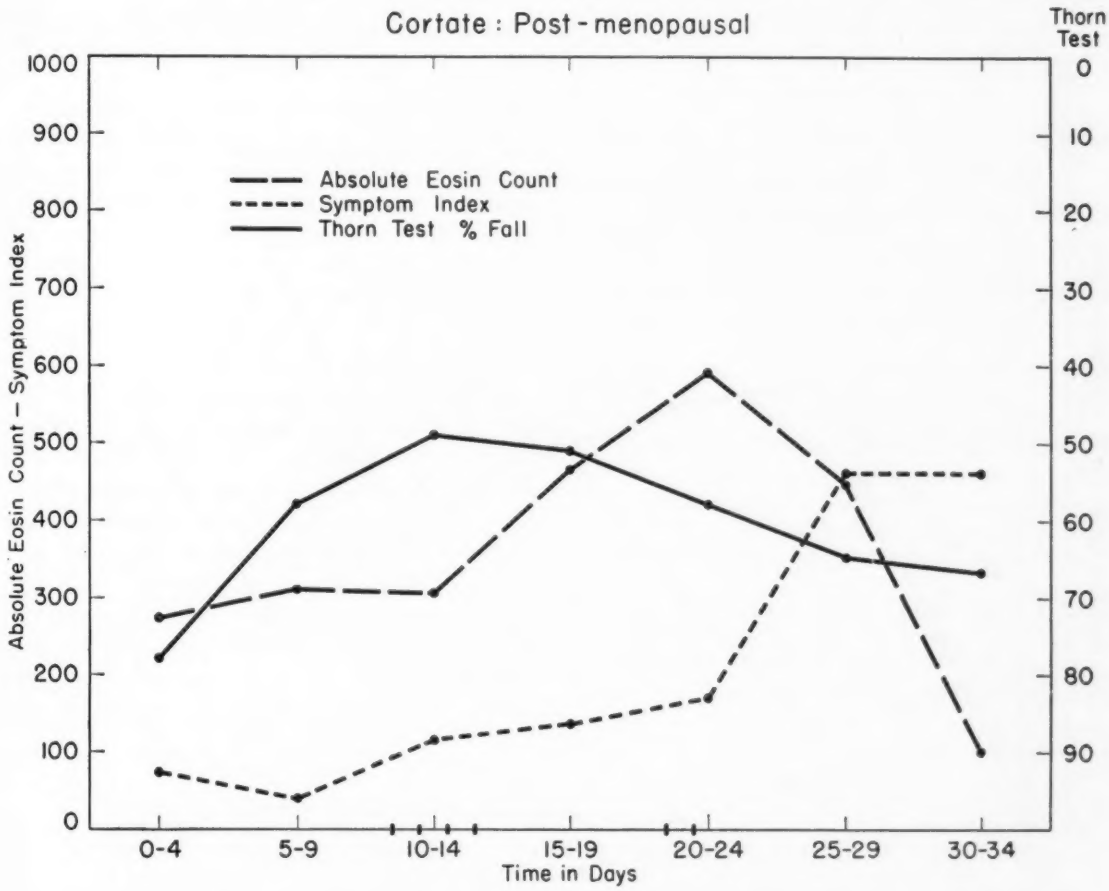

Chart and Graph viii. Postmenopausal patients of cortate group.

cated in the dramamine premenopausal and postmenopausal groups.

Comparison of the entire cortate-treated group to the entire control group is interesting in several respects. While the direction of change of the Thorn test curve in the cortate group is approximately the same as in the control group over the span of radiation therapy, it is noted that there appears to be relatively less loss of adrenal reserve by the ten to fourteen day period in the cortate group. Likewise, as in the dramamine group, the change of direction of the eosinophil curve is approxi-

Cortate : Pre-menopausal

Days	0-4	5-9	10-14	15-19	20-24	25-29	30-34	
Absolute Eosinophil Count	6	5	5	7	6	3	1	Number of determinations
	181	*127*	*308*	*527*	*371*	*751*	*363*	*Average cells / cu. mm.*
Thorn Test	6	5	5	6	5	2	1	Number of determinations
	63	*42*	*45*	*51*	*34*	*73*	*46*	*Average % fall*
Symptoms	19	26	23	30	23	19	7	Number of determinations
	111	*73*	*9*	*20*	*22*	*26*	*0*	*Average symptom index*

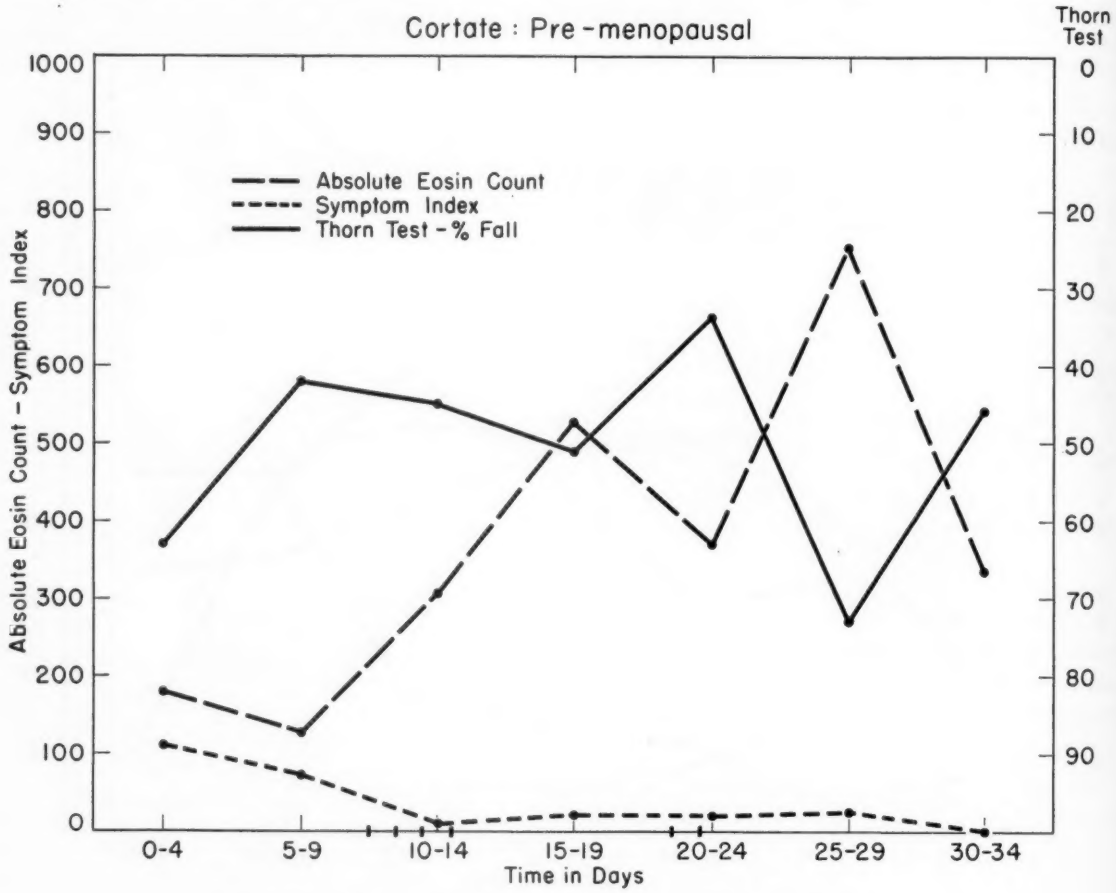

CHART and GRAPH IX. Premenopausal patients of cortate group.

mately the same as for the control group, but the curve does not reach quite as high a peak towards the end of the treatment period as does the control group. The symptom index curve shows perhaps the most clear cut change over the controls. There appears to be a definite flattening of the curve for the cortate group, extending through the last period of drug treatment (Charts and Graphs I and VII).

The postmenopausal cortate group curves show approximately the same relation to the control postmenopausal curves as do the curves of the entire cortate group

to the entire control group (Charts and Graphs II and VIII).

Except for the last portions of the eosinophil and Thorn test curves (where few determinations are available) the premenopausal cortate group also shows approximately the same relation to the control premenopausal group as does the entire cortate group to the entire control group (Charts and Graphs III and IX). Here, also, as in the control and dramamine groups, one notes a rather marked flattening of the premenopausal symptom curve as compared to the postmenopausal curve.

SUMMARY

Dramamine, administered under the conditions stipulated, causes some diminution in the eosinophil response of a group of patients receiving deep roentgen therapy for carcinoma of the cervix, but little recognizable alteration in the pattern of adrenal cortical response or in the pattern of symptomatic radiation sickness.

Cortate, when administered according to the method outlined in this study, appears to modify the response of the adrenal cortex, the development of peripheral eosinophilia, and the development of the symptoms of radiation sickness.

A study of the control, the dramamine and the cortate groups shows that in all three (total 50 patients) the premenopausal patients show distinctly less evidence of radiation sickness than do the postmenopausal group. The exact role that circulating estrogens may play in modifying the response to irradiation in the two groups is not yet known.

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THE INITIAL MEDICAL AND INDUSTRIAL USE OF RADIOACTIVE MATERIALS (1915–1940)

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INTRODUCTION

THE internal‡ use of radioactive substances followed the discovery of radioactivity in water of health springs in 1903.[13, 44, 70] The first internal use of radium chloride in this country was reported in 1913,[50] and thorium dioxide began to be used as a radiopaque medium in 1930.[68] The painting of watch dials with luminous material containing three radioelements, mesothorium, radiothorium, and radium, began in 1917.[4]

The harmful effects of radioactive materials were first discovered in luminous dial workers in 1924 by Blum.[9] Many of these women died from anemias, crippling bone lesions, and bone tumors. A clinical evaluation of 30 luminous dial workers and 50 persons who received radium therapeutically was completed recently (1952).[4,29] Results from these investigations indicate that small amounts of radioelements remain in the body for great lengths of time before damage occurs. Tumor formation and skeletal changes have been found twenty to thirty years after the deposition of the radioelements.

It seems reasonable to assume that the medical, military and industrial utilization of radioactive materials will continue to increase with great rapidity. Much information is needed to determine the quantity of a radioelement that can be retained for long periods of time without producing clinical change.§ The persons given radium therapeutically, thorium diagnostically, and the luminous dial workers constitute the principal source of clinical material for obtaining this information. It is hoped that many of these patients may be found by bringing to the attention of the medical profession the conditions for which the radioelements were used and the changes that may be produced. It is through the accumulation of clinical information that we may more adequately protect exposed individuals and more accurately establish the maximum permissible amounts of radioelements that can be safely retained by the body.

INTERNAL USE OF RADON AND RADIUM

The internal use of radioactive materials was largely based on the discovery of radioactivity in the waters of Cambridge, England, and Paris, France, by J. J. Thompson in 1903 and Pierre Curie and Laborde in

‡ The term internal is to denote radioactive substances metabolized by the body to differentiate it from other methods of use such as implantation.

§ It is known that radioelements produce pathological changes. The term clinical change is used to denote pathological change to such a degree that it is clinically significant.

* From 1950–1952 the author was a Post-Doctorate Atomic Energy Commission Fellow in Medical Science of the National Research Council at the Argonne National Laboratory. He was assigned the responsibility of the clinical aspects of an investigation of persons who were given radium salts orally and intravenously, and persons who were employed as luminous dial workers from 1915–1930 and its correlation with biophysical aspects of the investigation. This group was composed of the following: A. M. Brues, L. D. Marinelli, W. P. Norris, R. J. Hasterlik, and A. H. Stehney. In 1952 a study of persons who received thorotrast was initiated at the U. S. Naval Hospital in cooperation with the Naval Medical School, Naval Medical Research Institute and the Universities of Rochester and Utah. This group is composed of the following: J. B. Hursh, L. T. Stedman, J. S. Arnold, Martin Colodzin and the author.

A preliminary report on the skeletal roentgenographic findings in patients who received radium was made in 1951 (Argonne National Laboratory, Report No. 4666). A preliminary report on the skeletal roentgenographic findings in patients who received thorotrast was made at a conference on Internal Radioactive Contaminations, July, 1953, Copenhagen, Denmark (Seventh International Congress of Radiology).

The success of these investigations has been in a large measure the result of the excellent cooperation of the physicians, medical schools, and hospitals of the Chicago and Washington areas.

Detailed reports of the clinical, physical, radiochemical, roentgenographic and histological findings of the thorium and radium investigations will be published.

† The opinions and assertions contained herein are the private ones of the writer and are not to be construed as official, or reflecting the views of the Navy Department or the Naval Establishment at large.

1904 respectively. It was considered that the healing qualities which for centuries were thought to be the result of drinking and bathing in the water of the natural springs or spas was actually produced by radon, therefore this therapeutic agent could be made available to the general public.

To quote from one of the early workers, "It is thus that nature and accident and prophecy often point the way to discoveries of the highest importance to the human race, for it is now established beyond question that the waters of these springs contain radium emanation in varying but considerable amounts, and still further that the emanation as now scientifically procured by laboratory methods possesses healing powers far beyond the conception based on earlier experience."[43]

Considerable pioneer work was done to determine the biological effects of radioactivity. This was especially true with regard to radon because of the belief that it would produce beneficial effects in two ways, one by chemical means, the other by irradiation.

In 1911 Professor S. Saubermann[64] of Berlin presented to the British Medical Association a review of the status of the investigative work in the field of radiobiology. He concluded that radon increased autolytic fermentation, the activity of peptic ferment, pancreatic ferment, glycolytic fermentation, etc.

On the basis of the preceding data, it is easy to see why the therapeutic use of radon had such a spectacular and promising beginning and why it was tried as a therapeutic measure in such a wide number of diseases. Radon drinking water came into widespread use in this country. One of the companies manufacturing radon drinking water containers stated that 155,400 persons were using their product during their first year.[45] Reports of the therapeutic effectiveness of drinking water from the natural radioactive springs, artifically prepared radioactive water, radon inhalators, etc., began to occur with increasing frequency.[11,15,16,20,28,33,46,47] Rowntree and Bajeter (1913)[62] summarized the results of the use of radon by 20 foreign investigators on 1,038 patients. They made the following conclusions:

> The value of radium is unquestionably established in chronic and subacute arthritis of all kinds (luetic and tuberculous excepted); acute, subacute and chronic joint and muscular rheumatism (so called); in gout, sciatica, neuralgia, polyneuritis, lumbago, and the lancinating pains of tabes. 837 or over 80% of the patients were considered to have been improved by the use of radium emanation.

Because of the rapid elimination of radon and its short half-life (3.8 days), attention was directed toward the internal administration of radium (half-life 1,620 years). If radium were deposited in the body and eliminated slowly, then the radium remaining would constantly give off radon in the body. In 1914 Proescher[50] summed up the rationale for this change to the use of radium:

> The radium is excreted in the urine and feces, however the greater portion is deposited in the bone marrow. The organism is therefore not only passively but actively radioactive for a considerable period and of greater importance still, the action is constant. In other words, the body becomes a vital emanatorium due to the deposit of radium salt.

Proescher's first article on the intravenous use of radium chloride appeared in 1913.[50] In the period 1914–1916 several additional articles appeared on the internal use of radium[6,7,8,10,12,21,22,27,34,35,42,50,51,52,53,60,61,66,67,71] (see Table 1).

After this sudden and enthusiastic beginning of the therapeutic use of radium and radon, it appears to have declined in popularity as rapidly as it ascended. The following excerpt from an article by Allen, Bowing and Rowntree in 1927[1] summarizes the sudden rise and fall of the therapeutic administration of radium and radon.

> About fifteen years has elapsed since radium came into prominence in medicine. In the beginning, it was heralded by certain leaders of medicine in Germany and Austria as a remedy

TABLE I

RADIUM

Some of the Most Common Conditions for which Radium Was Given	Changes which May Occur		Aids in Diagnosis of Retained Radium
	Clinical	Roentgenographic	
Hypertension Cardiovascular disease Arthritis Duodenal ulcers Gout Neuritis Diabetes Mental diseases Syphilis Infected wounds Skin disorders Anemias Leukemia Nephritis Sciatica Raynaud's disease Buerger's disease	1. Aspectic necrosis of femoral head or bones of feet 2. Fractures of vertebrae or femoral shaft 3. Marked increase in dental caries; extrusion of bony spicules or osteomyelitis of mandible 4. Skeletal tumor formation	1. Small well differentiated areas of decreased density may be present in the skull, long bones or bones of the feet 2. Areas of increased density may occur in the vertebral bodies, humeral and femoral heads	1. History of radium administration 2. Detection of radon from expired air 3. Detection of gamma-ray activity given off from the body 4. Detection of radium in a urine or fecal specimen 5. Demonstration of roentgenographic changes

of great value. . . . The prominence of these writers made the claims quite convincing. The clinics of both Von Noorden and His, regarded by all as among the leading medical services of Europe, intimated that the introduction of radium would mark the beginning of a new era in therapeutics. The chief claims made for radium were that it relieved pain, that it activated enzymes, and that it reduced blood pressure.

In 1929 an editorial in the *Journal of the American Medical Association*[54] reviewed the reasons for the decision of the Council on Pharmacy and Chemistry for not accepting radium solutions or radon water as therapeutic agents because of the failure to demonstrate their value by controlled clinical evidence.

LUMINOUS DIAL WORKERS

Crookes in 1903 discovered that alpha rays striking a zinc sulfide screen produced luminescence. Self luminous paints began to be used on watch dials in 1908.[4] Radium was first used as a source of alpha particles in the luminous watch dial paints; later mesothorium and radiothorium were used for economic reasons. Self luminous paints began to be used in this country in 1913. They were used on instrument panels as well as watch dials. Martland[37] states that an accumulative total of 800 girls were employed by a New Jersey concern between 1917 and 1924. Similar luminous dial plants were in operation in Illinois and Connecticut.

In 1924 Blum[9] discovered that severe osteomyelitis and necrosis of the mandible occurred with great frequency in the workers of the New Jersey plant. The reports which followed[5,17,18,19,37,38,39,40,41,58] on the clinical course and death of these women from anemias, crippling bone lesions, bone tumors, have now become classics on the destructive effects of radioelements in humans.

THORIUM

The first colloidal preparation of thorium dioxide was used in 1928 in bronchial roentgenography. In 1929 Oka accidentally discovered the outlining of the liver and spleen roentgenographically. This was independ-

TABLE II

THORIUM

Some of the Most Common Conditions for which Thorotrast Was Used in Diagnostic Roentgenology	Changes Which May Occur		Aids in Diagnosis of Retained Thorotrast
	Clinical	Roentgenographic	
A. Visualization of liver and spleen 1. Amebic abscesses 2. Cirrhosis of liver 3. Metastases to liver	1. Induration or ulceration at site of injection 2. Anemias (irradiation of bone marrow) 3. Neoplasia (liver) 4. Leukemias	1. Increased density of liver and spleen 2. Long bones a. Thickening of trabeculae b. Longitudinal striations on medial surface of shafts c. Thickening of middle one-third of shafts 3. Increased density from extravasation into soft tissues at site of injection	1. History of administration 2. Visualization of deposition in liver and spleen 3. Detection of particles of gamma-ray activity given off from the body 4. Induration and/or ulceration at the site of injection (neck, arm or thigh)
B. Cerebral arteriography 1. Anomalies 2. Aneurysms 3. Hemangiomas 4. Neoplasia of brain			
C. entriculography			
D. Encephalography			
E. Disorders of genitourinary tract			
F. Mammography			
G. Arteriography of extremities 1. Arteriosclerosis 2. Hypertension 3. Buerger's disease 4. Raynaud's disease 5. Aneurysms			

ently verified by Radt who improved the preparation and introduced it into clinical use as thorotrast.*[56]

Yater and Coe[75] considered that the greatest usefulness of thorotrast was in the diagnosis of metastases to, and abscesses of the liver, and early cases of cirrhosis.

Thorotrast, when injected into the blood stream, is rapidly taken up by the reticuloendothelial system. Two-thirds of it is deposited in the liver and spleen. It is also consistently found in the bone marrow and lungs.[56,73] Once deposited in the body, elimination is extremely slow.[26,55] Several reports indicate that no appreciable amount of thorotrast seems to have been eliminated years after administration, by roentgenographic examination of the liver and spleen.

In 1929 Egas Moniz first visualized cerebral structures and the cerebral vascular tree by injecting thorotrast into the carotid artery, and Radovici and Meller of France in March, 1932, and Westmann of Germany were the first to report its use intracranially.[68] Thorotrast was also used for outlining the genitourinary tract,[56] placenta,[56] breast,[14,24,25,59] and blood vessels of the extremities[2,72,74] (see Table II). Thorotrast as a radiopaque medium seems to have been used less and less frequently in the past few years. Pirkey *et al.*[48] in 1951 stated that they were only using thorotrast in extremely puzzling cases in the older age groups.

AVAILABLE CLINICAL INFORMATION

The marked increased use of radioactive materials has made the problem of late clinical change one of considerable importance. This is especially true of such radioelements as thorium,† plutonium, radium,

* Thorotrast contains 25 per cent thorium dioxide by volume (20 per cent by weight) and about the same amount of a protective colloid, a dextran preparation, and 0.15 per cent methyl-P-hydeoxy benzoate as a preservative.[69]

† Thorium has a half-life of 1.39×10^{10} years. The thorium present in the amount of thorotrast used in obtaining a hepatogram (75 cc.) has an estimated gamma-ray activity equivalent to 1.37 micrograms of radium and an estimated alpha activity equivalent to 1.5 micrograms of radium. Schlundt, H.—unpublished data.

Fig. 1. Roentgenogram of the forearm taken thirty years after employment as a luminous dial worker. The multiple, small, well differentiated areas of decreased density give a "streaked" appearance to the radius, ulna, and bones of the hand.

etc., which have long physical and biological half-lives. It is extremely difficult to estimate the quantity of these radioelements that can be safely retained because of the long duration between radioelement deposition and damage.

(*A*) *Radium Patients and Luminous Dial Workers.* Aub, Evans, Hempelmann and Martland (1952) reported the results of their clinical evaluation of 19 persons who were former employees of luminous dial plants and 11 persons who had been given radium internally. The present author has been associated with a similar study in which 36 persons given radium and 14 luminous dial workers have been evaluated.[29]

Aub, Evans, Hempelmann and Martland found characteristic skeletal changes produced by radioelement deposition in all patients having more than 0.7 microgram of retained radium. Skeletal tumors developed in 8 of these patients twenty-three years after the deposition of the radioelements.

Findings in the 36 patients given radium and 14 luminous dial workers were similar. Symptoms in which there was some relation to radium deposition occurred in about 50 per cent of these persons. The onset of the symptoms was about fifteen years after the deposition of the radioelements. There was a marked increase of skeletal changes in patients having over 1 microgram of retained radium. These changes have been divided into three groups:

Group I. Areas of decreased density.

A. Longitudinal areas which occur in the long bones and give a "streaked" appearance. These areas are usually 1–2 mm. in width and 5–10 mm. in length (Fig. 1).

B. Well differentiated areas which vary from 2–20 mm. in the greatest dimension which may be oval, square, or irregular in outline. They usually occur in the skull, long bones, and bones of the feet.

Group II. Areas of increased density, usually associated with varying degrees of decreased density and change in trabecular pattern (Fig. 2).

These changes present a "mottled" or "moth-eaten" appearance and they usually occur in the heads of the femora and humeri, and the glenoid process.

Group III. Changes in the normal configuration and areas of destruction.

The term "aseptic necrosis" has been used in referring to these changes. The heads of the femora, bones of the feet and mandible were most commonly involved.

Three of these 50 patients had skeletal tumors which developed about twenty years after the deposition of the radioelements.

Even though the minimal hematological changes did occur somewhat more frequently in patients having greater amounts of retained radium they were not consistent. From this and previous hematological

data, it would seem that significant hematological changes usually do not occur until the disease process is more advanced.

Detailed studies reported by Aub, Evans, Hempelmann and Martland[4] and Looney,[30] and Looney and Woodruff[52] have shown that a relation exists between the skeletal roentgenographic findings, histopathological changes, and radium deposition. The frequency of bone tumor of approximately 10 per cent in the 80 patients is many times greater than the estimated incidence of bone tumor in the general population

(*B*) *Thorotrast Patients.* Numerous reports on the biological effects of thorotrast have appeared in the literature.[56] Cursory studies have been made on approximately 4,800 individuals given thorotrast since it was first used in this country in 1930. No significant number of clinical disorders have been found in these persons which might be attributed to thorotrast administration.

Yater and Coe (1943)[75] were unable to demonstrate any evidence of damage from latent radioactivity, depression of hepatic, splenic, or hematopoietic function, lowered resistance to infection, or development of malignant neoplasia at the site of injection, in a ten year follow-up of 286 cases given thorotrast. A similar study of a three year follow-up on 175 patients was done by Rigler, Koucky and Abraham[57] in 1935 with few or no harmful effects demonstrated. In 1950 Henry, Kaplan and Thomas[23] reported the experiences of 132 radiologists with thorotrast. Two unpublished cases of malignancy were found in 4,325 patients given the radiopaque medium.

In 1947 MacMahon, Murphy and Bates[36] reported a patient who died twelve years after receiving thorotrast. At autopsy, an endothelial sarcoma of the liver was found. They concluded there was a widespread radiation injury affecting particularly the liver and hematopoietic system. Although suggestive, they made no definite conclusions concerning the relationship of the sarcoma of the liver and the thorotrast. Spier, Cluff and Urry (1947)[65] reported a case in which an aplastic anemia developed

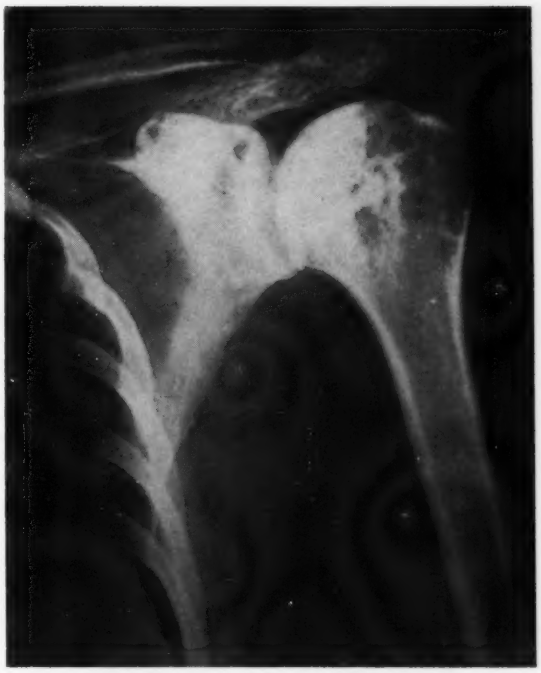

Fig. 2. Roentgenogram of the shoulder of the same patient as in Figure 1. Note the areas of increased density in the head of the humerus and glenoid process near the articular surfaces that result in a mottled appearance of the bones.

nine years after the administration of thorotrast. They found more thorium in the bone marrow (4.8 per cent of thorium oxide by weight) than in the spleen (0.25 per cent) by chemical analysis of the ignited residue. More alpha, beta, and gamma-ray activity was detected in bone marrow than in the spleen (counts per minute per gram of tissue). An anemia developed in a patient ten years after the administration of thorotrast which resembled pernicious anemia. Ten months after the onset of the anemia the patient died and during his terminal illness the diagnosis of lymphatic leukemia was made. Radioautographs of the specimens from the liver, spleen and skeleton have been made. There were numerous alpha tracks present in radioautographs of the liver and spleen. They were also randomly distributed throughout compact bone from the femur.[31]

Amory and Bunch (1948)[3] reported 7 cases in which thorotrast was demonstrated in the perivascular spaces years after ad-

Fig. 3. Roentgenogram of a tibia twenty years after thorotrast administration. Note the striated appearance of the tibia at the top of the figure and the thickened middle third of the shaft. The endosteal surface has an irregular outline.

ministration. Local reaction to the thorotrast resulted in marked induration. Symptoms from the local reaction occurred in 5 of 7 cases seen by Amory and Bunch. Prezyna, Ayres and Mulry (1953)[49] demonstrated radioactivity at the site of injection in a patient who had thorotrast twelve years previously.

We have begun a re-evaluation of the patients seen by Yater and Coe in their ten year follow up (1943) and all other available patients in the Washington area given thorotrast. In the past four months 17 patients have been evaluated. We have found no significant clinical changes other than local reaction at the site of injection if some of the material was inadvertently deposited outside the vein.

Small changes in the normal skeletal pattern* have been demonstrated on complete skeletal roentgenographic examination in approximately one-half of these persons. They have occurred most often in the humeri, radii, ulnae, tibiae and femora. In some instances there is thickening of the trabeculae, in others there are areas of decreased density similar to those seen in patients given radium, and luminous dial workers. There were also linear areas of increased density which appeared to follow the vascular supply to the bone. Some of the shafts of the long bones had an increased thickness and a peculiar striated appearance along the middle third with a slight expansion at the ends (Fig. 3).

Roentgenograms of the liver and spleen taken fifteen to twenty years after the administration of thorium have a less confluent and uniform distribution of thorotrast than roentgenograms taken shortly after administration. Migration, probably to the lymph nodes, is shown roentgenographically (Fig. 4).

It is possible that a certain portion of the thorium, or one or more of its daughter elements, may be deposited in the skeleton at the time of administration or migrate from the liver and spleen to the skeleton. This is based on the following information: the roentgenographic evidence of migration to the regional lymph nodes; the skeletal changes being observed in some of the 17 patients studied in this laboratory; the detection of larger amounts of thorium in bone marrow than in the spleen of a patient who died nine years after receiving thorotrast; and the demonstration of radioactivity in compact bone of a patient who had received thorotrast ten years previously.

Most distribution studies on thorotrast have been done in animals but were of re-

* The writer wishes to express his appreciation to Dr. Wallace M. Yater and Dr. Fred O. Coe, Washington, D. C., and to Dr. Joseph C. Aub and Dr. Merrill C. Sosman, Boston, Mass., for reviewing the skeletal roentgenograms on some of these patients.

latively short duration. Numerous reports have been made on the deposition of thorotrast in bone marrow but little has been published about deposition in compact bone.[63] In spite of this sparsity of information, it is possible that some relation does exist between the skeletal roentgenographic changes we have observed in patients and thorotrast administration. It is well established that thorotrast is eliminated extremely slowly from the body. It is known that there are architectural differences in the bone structure of man and animals. Changes may have been produced in man and not in animals because of the structural differences in bone and the presence of thorotrast for great lengths of time. It is also possible that the skeletal changes are produced by daughter elements of thorium, mesothorium, and radiothorium, either by migrating from the liver and spleen or by the presence of thorium in the skeleton.

The possibility that some changes are produced by the presence of the radioelement rather than from radiation cannot be dismissed. It is obvious that additional information will be necessary before any definite conclusions can be reached in regard to thorium.

CONCLUDING STATEMENTS

It is evident that thousands of persons received radioactive materials diagnostically and therapeutically twenty to thirty years ago (radium 1915–1930, thorium 1930–1945). Hundreds of persons were employed as luminous dial workers before adequate safety measures were taken (1917–1925).

It has been established that skeletal change, tumor formation and symptoms from bone necrosis may occur many years after the deposition of the radioelement. In many instances patients will not remember radioelement administration or employment as luminous dial workers. Familiarity with the late changes of radioelement toxicity will in some instances facilitate the correct diagnosis of bizarre and puzzling conditions in the middle and older age groups (see Tables I and II). These persons constitute the major clinical source of material for determining the safe amounts of radioelement that can remain in the body for long periods of time without producing significant clinical change or tumor formation. Extensive studies of radioelement deposition and biological changes by chemical, physical, histological, and radioautographic means at autopsy will be of great value.

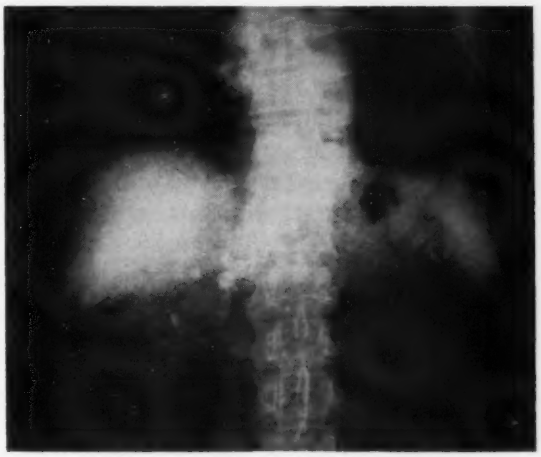

Fig. 4. Roentgenogram of the liver and spleen twenty-three years after thorotrast administration. Note the lacy appearance in contrast to a confluent increase in density throughout these organs shortly after thorotrast administration. The areas of increased density under the liver are probably the result of the migration of thorotrast to the regional lymph nodes.

These patients may be of considerable value in the following ways in addition to more accurately establishing the maximum permissible levels of exposure: (1) by avoiding mistakes in the present and future use of radioactive materials from greater knowledge of the effects of their first clinical use; (2) by bridging the large gaps in our present knowledge of the pathologic physiology of radioelement toxicity through locating and periodic re-evaluation of these persons; (3) by utilizing the patients to evaluate new methods devised for removing radioelements from the body; (4) by providing an excellent source of material for educational purposes in regard to chronic radioelement toxicity.

It is urged that any patients having retained radioelements be referred to laboratories* equipped to evaluate their status and determine the residual radioactivity. It is through the accumulation of information from these persons that we may more adequately safeguard the future health of increasing numbers of individuals who may be exposed to radioactive materials.

SUMMARY

1. Thousands of persons were given radioactive materials in clinical medicine twenty to thirty years ago. Radium chloride was given orally and intravenously in the treatment of hypertension, arthritis, gout neuritis, gout, etc., from about 1915 to 1930. Thorium dioxide was used in diagnostic radiology from about 1930 to 1945.

2. Hundreds of persons ingested or inhaled significant amounts of radium, mesothorium, and radiothorium in the luminous dial painting industry from about 1917 to 1925 before adequate protective measures were taken.

3. Recent studies (1952) on luminous dial workers and patients given radium therapeutically have revealed that fifteen to thirty-five years may elapse before symptoms, skeletal change or tumor formation occur.

4. Small skeletal changes have been found in patients given thorotrast fifteen to twenty years ago (1952).

5. These persons constitute the major source of clinical material for determining the amounts of a radioelement that can be retained safely by the body for protracted periods of time.

6. The importance of locating these individuals and referring them to a laboratory equipped to determine the residual radioactivity is stressed.

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* Other Laboratories known to be evaluating these persons are: (a) Dr. Joseph C. Aub, Harvard Medical School and Dr. Robley D. Evans, Massachusetts Institute of Technology, Boston, Massachusetts; (b) Argonne National Laboratory, Chicago, Illinois; (c) Dr. Louis H. Hempelmann, Strong Memorial Hospital, Rochester, New York.

A bibliography on radium that was initiated by the author was completed by Miss Ellen Skirmont of the Argonne National Laboratory. The author wishes to express his appreciation to Dr. Jerome Boseman for the roentgenograms of the luminous dial worker.

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THE DISTRIBUTION OF RADIOIODINE OBSERVED IN THYROID DISEASE BY MEANS OF GEIGER COUNTERS—ITS DETERMINATION AND SIGNIFICANCE

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RADIOACTIVE iodine I^{131} is being used increasingly for studies of the localization and distribution of normal and abnormal functional thyroid tissue (Ansell and Rotblat, 1948; Veall, 1950; Blomfield *et al.*, 1951; Taylor and Stewart, 1951). Before 1950 Geiger counters were used for which the resolving power appeared to be poor and Veall (1950) designed a directional counter for I^{131} using a lead cathode counter which gave a six-fold increase in resolving power without loss of count-rate. The lead shield used was designed solely for collimation; the weight (4 lb.) was thus kept so low that it could be held in the hand, which in practice is a very useful feature. The Veall counter was used for the distribution studies reported by Blomfield *et al.* (1951) and by Taylor and Stewart (1951) although these observers did not use identical procedures.

From the observations so far reported it is still not very clear which are the best methods and apparatus to use to obtain the greatest amount and precision of information. The purpose of this paper is to describe some work we have done in this field which we believe adds a little to existing information and to outline a method of studying radioiodine distributions which is relatively simple but informative.

REQUIREMENTS OF THE COUNTER SYSTEM

1. *Some General Considerations.* The resolution of a counting system is usually expressed in terms of point sources. In practice, however, one is concerned most frequently with exploring relatively large masses which are sometimes of considerable area. The essential question is, how well do the lines of equal count-rate (isocount-rate-contours) represent the shape and extent of the active area explored?

We considered that some kind of answer to this question might be provided by observations with various active sources of known geometric shape, dimensions and position, using for these observations Geiger counters with varying degrees of collimation and shielding.

By making certain simplifying assumptions it is possible to calculate approximately some of the results to be expected from such observations. Thus, with perfect collimation it should be found that, for distances d from the source to the front of the counter between 5 and 10 cm., the count-rate varies with the source thickness independently of d. Therefore, with perfect collimation and a uniform activity distribution throughout the active tissue, it should be possible to deduce the variation of thickness of the active tissue. Also, for thicknesses of active material between about 1 and 5 cm., the variations of count-rate with distance from the source are approximately independent of the active thickness. This implies that from measurements made at various distances from the patient, it might be possible to deduce the relative depth at which, say, a metastasis is situated, irrespective of its size.

In practice, however, collimation is not perfect. If the counter is above a distrib-

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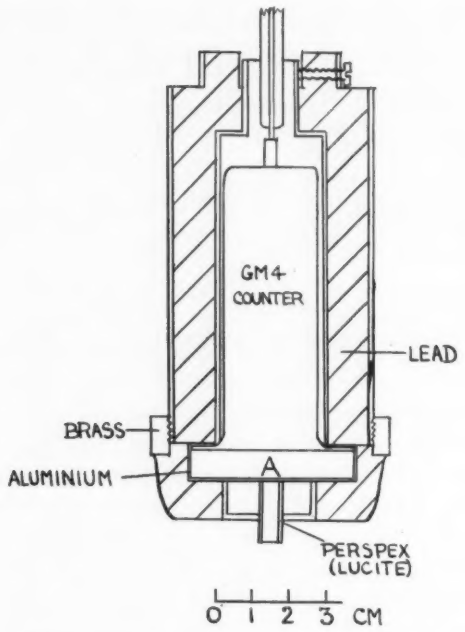


FIG. 1. Large aperture counter system. It is changed into the small aperture counter by the insertion at *A* of a lead disc 1 cm. thick with a 0.5 cm. diameter hole.

uted active source, the count-rate observed will be due to both the direct radiation received through the aperture (which is wanted) and to the stray radiation entering obliquely through the collimating shield from other parts of the source (which is unwanted). If, for simplicity, it is assumed that all the stray radiation passes through a constant thickness of lead shielding we may deduce approximately the relative count-rates due to direct and stray radiation. Thus, if the lead shield is 1 cm. thick and the aperture 0.5 cm. in diameter, for a counting distance of 5–10 cm. from a source of I^{131} of 2.5 cm. radius, the count-rate due to stray radiation will be nearly 4 times as great as that due to direct radiation. If the source radius is 5 cm. the ratio 4 increases to about 13. An increase in shielding thickness to 2 cm. of lead reduces these ratios to about 0.3 and 1.0 respectively.

It is clear that under many conditions which may arise in practice, the stray radiation count will be a large proportion of the total count. Assuming that the counter shield is already as thick as practical considerations of portability, etc., will permit, the proportion of stray radiation count may be reduced by increasing the aperture. This, however, reduces the resolution of the counter. What conditions, then, produce the best isocount-rate contour interpretation of an extended source? A small aperture with good geometry but a high proportion of stray radiation or a large aperture with bad geometry but a smaller proportion of stray radiation? Simple calculations regarding this point for two counter systems (to be described below) with the same shielding but different apertures show that for an extensive disc source the large aperture counter gives slightly the better resolution beyond the geometrical edge of the source.

2. *Some Experimental Observations.* Our experiments were done using the following counters:

(a) The lead walled counter described by Veall (1950), having a lead shield approximately 1 cm. thick and a very small aperture.

(b) A G.E.C. copper-walled end-window *G.M.4* counter built into a lead shield approximately 1 cm. thick (Fig. 1) having an aperture *A* 2.5 cm. in diameter, the full aperture of the counter. The thin aluminum window of the counter is covered by a 1 mm. thick Al filter. Also mounted in the aperture is a center indicating device of perspex. The counter thus responds to only the gamma rays from I^{131}. This will be called the large aperture (L.A.) counter. Its weight is 3 pounds.

(c) This counter is identical to (b) except that the aperture *A* is stopped down to 0.5 cm. by means of a lead diaphragm 1 cm. thick. This will be referred to as the small aperture (S.A.) counter.

Observations were made with the counters using an approximate point source of I^{131} and several extended sources. The point source was a short thread of I^{131} solution drawn up into a 2 mm. diameter capillary tube. The extended sources were rectangular perspex boxes of up to 125 cc. capacity which were completely filled with I^{131} solution. A counter was positioned first above the center of a box and then the count-

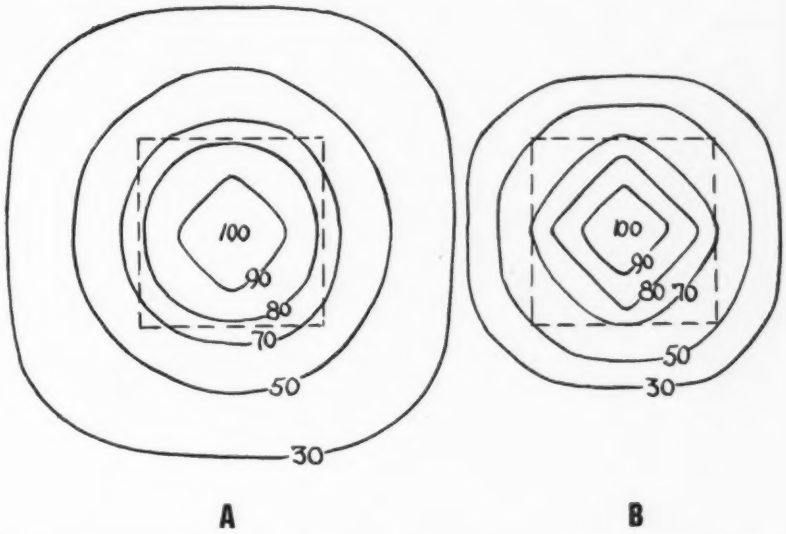


FIG. 2. Isocount-rate contours measured above a source 5×5 cm. in area and 1.25 cm. thick. Counter-source distance 2.5 cm. Maximum count-rate = 100 at center. (*A*) With small aperture counter. (*B*) With large aperture counter.

rates were determined on a count-rate meter at various known points in a plane parallel to the upper surface of the box.

With the point source and a counter-source distance of 2.5 cm., the Veall counter showed a fall to 50 per cent of maximum at a distance of 0.7 cm. from the counter-source axis. For the L.A. counter and S.A. counter the corresponding distances were 2.1 cm. and 2.7 cm. respectively. For a point (or very small) source the Veall counter shows much the best resolution.

Three extended sources were used, being (1) a source 5×5 cm. in area and 1.25 cm. thick; (2) a source 5×5 cm. in area and 5 cm. thick; (3) a source 10×10 cm. in area and 1.25 cm. thick. All measurements were made with a distance of 2.5 cm. between the front of the counter and nearest face of the source. From the observations the isocount-rate contours "representing" the source were evaluated, the maximum count-rate observed at the center of the source being taken as 100 per cent.

Isocount-rate contours obtained for the first source using the S.A. counter and L.A. counter are shown in Figure 2, *A* and *B*, respectively. The actual shape and orientation of the source is shown in dotted outline. In neither case is the source shape well shown. The higher count-rate contours suggest that the source is at 45° to its true position while the lower contours give an indication of the true shape, but not of the true size. It is interesting that the fall-off of count-rate beyond the geometrical edge of the source is more rapid with the L.A. counter than with the S.A. counter. For both counters a 60 per cent contour corresponds very roughly to the actual source.

The results of similar observations for the second source are shown in Figure 3, *A*, *B* and *C*, using the S.A. counter, the L.A. counter and Veall's counter respectively. All three suggest the 45° orientation of the source from its true position. The differences between the results with the S.A. and the L.A. counters are not very marked although the fall-off beyond the geometrical edge is now slightly more rapid with the S.A. counter. The fall-off with the Veall counter is most rapid towards the edge of the source but at large distances beyond the edge of the count-rate rises again as indicated by the outer 30 per cent contour. Beyond this the count-rate actually rose to 50 per cent, thus suggesting that the central source was surrounded by a large ring

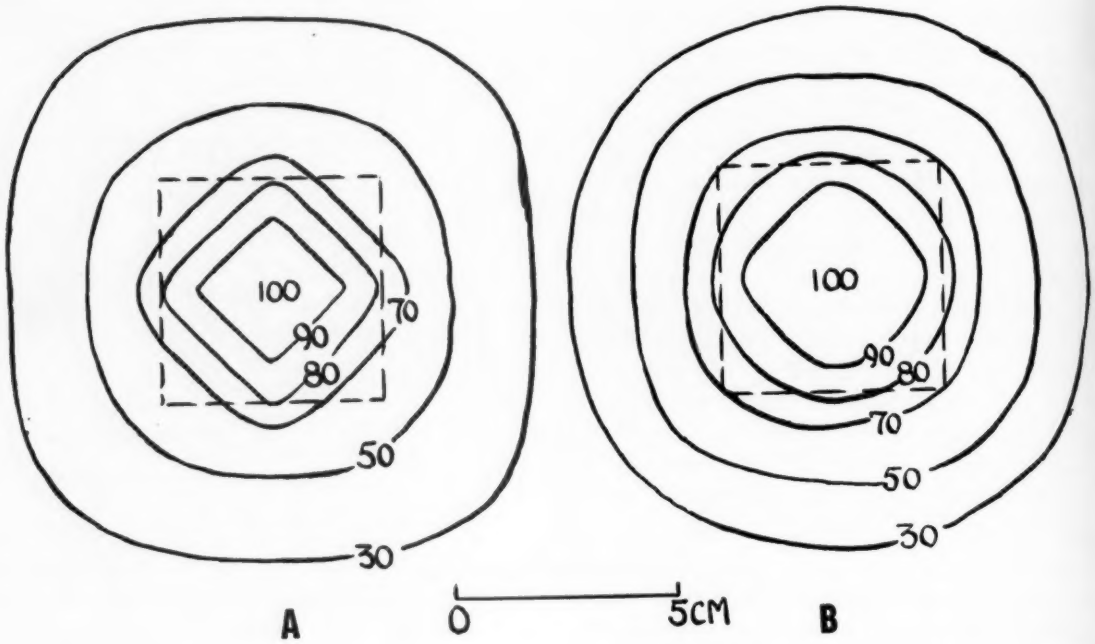
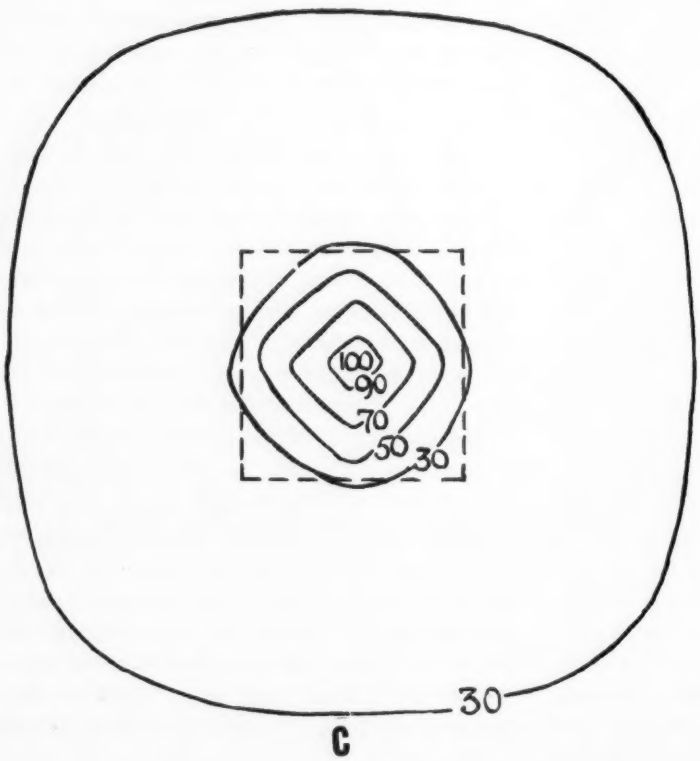


FIG. 3. Isocount-rate contours measured above a source 5×5 cm. in area and 5 cm. thick. Counter-source distance 2.5 cm. Maximum count-rate=100 at center. (*A*) With small aperture counter. (*B*) With large aperture counter. (*C*) With Veall's counter.



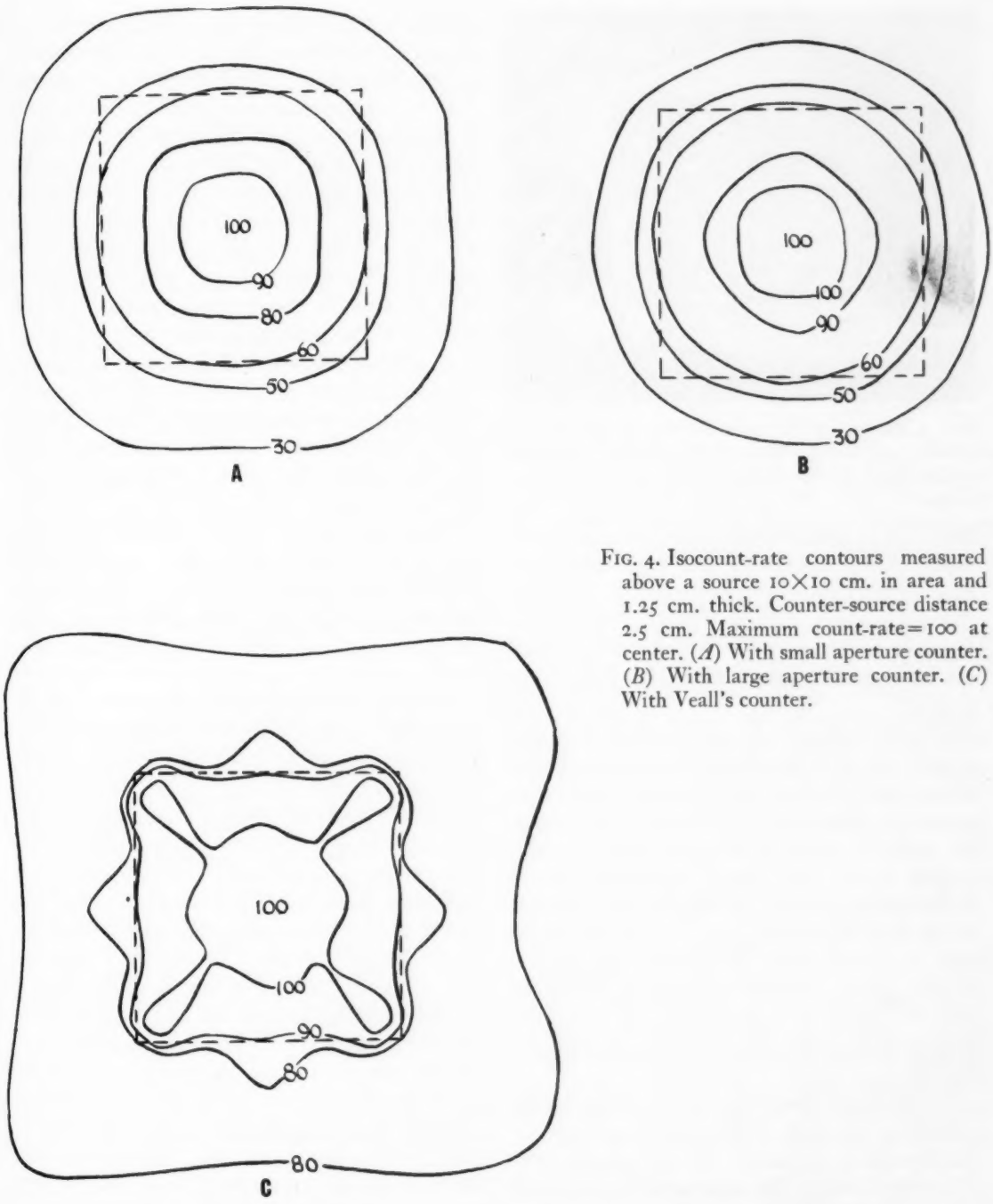


FIG. 4. Isocount-rate contours measured above a source 10×10 cm. in area and 1.25 cm. thick. Counter-source distance 2.5 cm. Maximum count-rate=100 at center. (*A*) With small aperture counter. (*B*) With large aperture counter. (*C*) With Veall's counter.

of active material. This rise is of course due to radiation entering the side of the shielding from the source.

Figure 4, *A*, *B* and *C*, shows the results for the third source obtained using the three counters in the same order. The S.A. and L.A. aperture counters present very much the same picture, the latter giving just a little more rapid fall-off beyond the geometrical edge. In both cases the 50 per cent contour corresponds very roughly with the actual source. The contours obtained with the Veall counter are most interesting. The count-rate fell to about 80 per cent at

FIG. 5. Plaster cast of neck showing coordinate system marked on it. Also an outline of the nodule and the observed isocount-rate contours.

the edge of the source, a little more at several centimeters from the edge and then rose again to 80 per cent some 5 cm. from the edge. For a large source such as this the counter apparently gives little or no reliable information concerning the size of the source.

These results all show that caution should be used in deducing actual shapes of radioactive sources from isocount-rate contours. They also indicate that the counter system used by Ansell and Rotblat (1948) with very heavy shielding and a large aperture does not merit the criticism made of it (Veall, 1950). This is also borne out by Ansell and Rotblat's own results with a known source of 5 inch diameter, but of course the possibility of incorrect orientation of the source could not be observed.

Veall (1950) has pointed out that the detail obtained with a directional counter depends on the resolution of the counter; also that reduction of the aperture decreases the count-rate and increases the statistical error for a fixed time of measurement. There is therefore an optimum value for the aperture at which uncertainties due to statistical errors are equal to those due to the finite angle of resolution of the counter.

Our experiments show that the count due to radiation entering the counter obliquely through the collimating shield is also an important factor. The shield thickness is often limited by considerations of portability, anatomical accessibility, etc., and it is apparent that for a given shielding there will be an optimum size of aperture to produce the sharpest picture—when the ratio of stray to direct count falls off most rapidly beyond the geometrical edge of the source. The errors due to stray radiation will depend on the gamma-ray energy and will increase with its penetrating power.

3. *Some Clinical Studies.* For a variety of purposes clinical studies have been made periodically of the count-rate distribution due to uptake of I^{131} at various sites in the human body after giving a tracer dose of I^{131} by mouth.

Because, of our three counter systems, the L.A. counter gives the most definite picture and at the same time has maximum efficiency and adequate portability, this counter has been used for our clinical studies.

Various methods have been used to relate geometrically the observed count-rate distributions to the actual anatomical site containing the activity (*e.g.*, Ansell and Rotblat, 1948; Blomfield *et al.*, 1951; Taylor and Stewart, 1951). Our method has been to prepare a closely fitting plaster cast of the anatomical region concerned, on the outer surface of which a rectangular coordinate system is drawn. The tissue volume of interest can then be readily fixed in relation to the coordinate system. From count-rate measurements made with the counter centered perpendicularly above a wide range of points in the coordinate system while the plaster cast is on the patient, it is easy to deduce the isocount-rate curves over the surface of the cast, which approximately corresponds to the anatomical surface. Various information is supplied by the contours, depending upon the nature of the case being studied. We illustrate the procedure by the following cases.

CASE 1. This is a girl aged thirteen in whom the thyroid had been excised at four years of age. A small nodule had developed in her neck

and we wished to determine whether this was functioning thyroid tissue, and if so, whether there were any other similar but non-palpable nodules.

A plaster cast (Fig. 5) was made of the anterior half of her neck extending upwards to include the chin and downward to the clavicles in order that it would remain firmly in position during counting. The coordinate system was marked on the cast, the origin being taken just over the nodule, the outline of which was also marked on the cast.

A 50 μc. I^{131} tracer dose was given at 11.00 A.M. and the count-rate observations were made between 2.20 P.M. and 2.45 P.M. The final isocount-rate contours (in counts per minute) are shown in Figure 6 as a plane diagram although of course, in the original, the diagram was on the surface of the cast (see Fig. 5). The outline of the palpable node is shown by the broken contour.

The diagram shows without doubt that the nodule has accumulated I^{131} and is functioning thyroid tissue. Remembering that in our smaller source experiment the lower value contours approximated the shape (but not the size) of the source, the shape indicated is very close to that of the nodule. It is also clear that there are no other nodules of thyroid tissue present and in view of the response of the L.A. counter to a point source of I^{131} it is highly probable that the palpable bulk of the nodule represents all the functioning tissue present.

Case II. In this case we studied I^{131} uptake in a metastasis from carcinoma of the thyroid which had developed in the right humerus of a woman who had undergone total thyroidectomy about two months before this test. A full report of this case will be published elsewhere; our concern here is only with the results of this study and their application.

A plaster cast was made around the whole of the right arm at the affected site, of sufficient length to include the metastasis as seen in the roentgenograms. The cast was split for removal and for re-application as desired. A coordinate system was marked over all that region of the cast which was accessible for counting. This comprised the outer, anterior and posterior aspects. The inner aspect was inaccessible because of the pain experienced by the patient in attempting to abduct her arm.

A 1.9 mc. dose of I^{131} was given at 2.20 P.M. on one day and the counting was done between

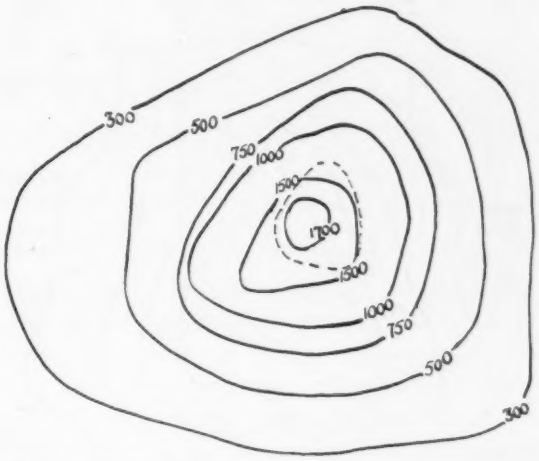


Fig. 6. Plane diagram showing the isocount-rate contours determined over the cast of the neck using the large aperture counter. The broken line represents the contour of the palpable nodule suspected to be thyroid tissue. Numbers on count-rate contours are counts per minute.

10.30 A.M. and 12.00 noon on the following day when approximately 1 mc. was still retained by the patient. The isocount-rate contours (in thousands of counts per minute) determined over the surface of the cast are shown in Figure 7*A* as a plane diagram. In this diagram the line *XOX'* runs approximately from just above the elbow up towards the shoulder and the line *YOY'* runs around the arm.

Roentgenograms indicated that the metastasis was approximately cylindrical, in length approximately 5 cm. and diameter 3.5 cm. so that its volume could be estimated at 48.3 cc. It was considered of interest to attempt a "reconstruction" of the situation. To this end a thin-walled hollow ebonite cylinder (5 cm. long and 3.5 cm. diameter internally) was filled with I^{131} solution of known concentration (6.90 μc./cc.) and mounted inside the plaster cast in the position of the metastasis. The remainder of the cast was filled with a rice flour and sodium bicarbonate mixture (Spiers, 1943) to simulate soft tissue. The isocount-rate contours over the cast were now redetermined with the result shown in Figure 7*B*.

Comparison of Figures 7*A* and 7*B* shows that there is sufficient agreement between the two sets of contours to permit the assumption that the metastasis did not differ widely from the cylinder taken to represent it. This in turn suggests that all the tissue seen as metastasis in the

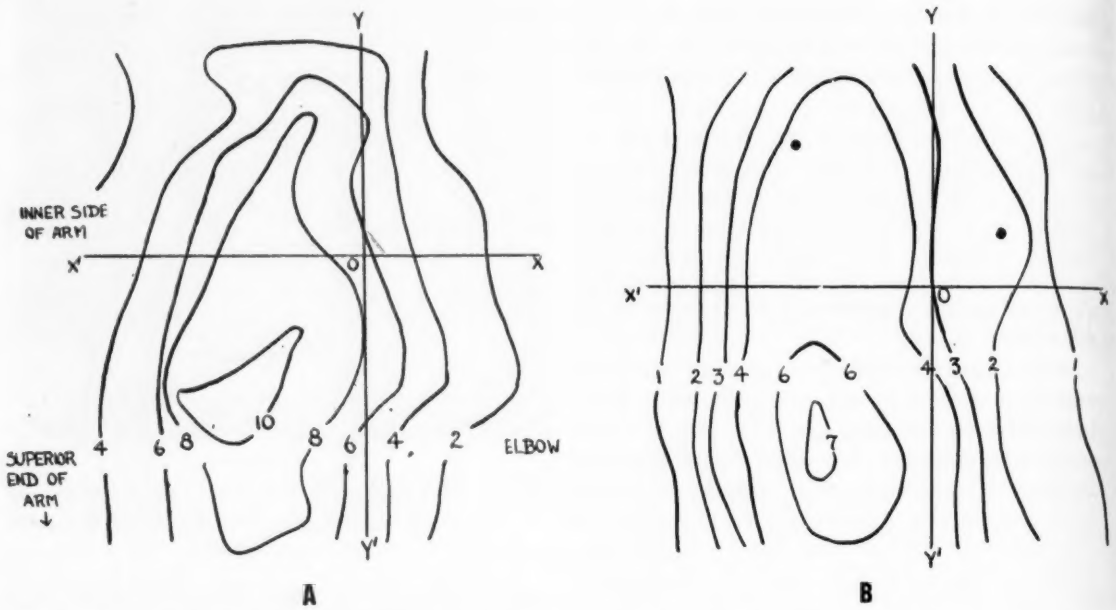


FIG. 7. Plane diagrams showing the isocount-rate contours determined on plaster cast of arm. Numbers on contours are thousands of counts per minute. (*A*) Actual arm inside the cast. (*B*) Actual model of metastasis inside the cast filled with Spiers' mixture.

roentgenogram was functioning as thyroid tissue. On this basis it was then possible to estimate* the activity present in the metastasis as 1.66×6.9 μc./cc. $= 11.4$ μc./cc. approximately.

Following this tracer examination treatment was instituted with therapeutic doses of I^{131} and by means of count-rates observed daily at a number of points on the cast when on the patient's arm, it was possible to determine approximately the concentration of radioisotope in the metastasis and its variation with time. From these data a fairly good estimate of tumor dosage in reps was possible. As will be shown in a later complete case report the metastasis responded extremely well to the therapy so that the tumor dose data thus obtained were of particular interest and value.

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* The estimate is admittedly rough but even this is very much better than none at all. In actual fact, it is far more accurate an estimate than is possible in many cases of isotope therapy in its present stage of development.

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A PROTECTIVE EFFECT OF INORGANIC MAGNESIUM AGAINST ROENTGEN RADIATION DAMAGE TO HYDRA

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MANY agents used in an attempt to prevent roentgen radiation damage have been complex organic substances or even more highly organized biological debris.[2,3,4] The results reported in the present paper show that in the relatively simple organization of the common brown Hydra inorganic magnesium is highly effective in preventing and alleviating the symptoms of acute irradiation damage.

Five morphological abnormalities have been used to assess the effectiveness of added substances. The abnormalities are as follows: (1) loss of ability to adhere to the walls of the containing vessel; (2) loss of extensibility (the Hydra assumes a "short body"); (3) opening of the mouth—this is not the same reaction as the normal opening of the mouth incident to the regurgitation of food residue or other extraneous matter present in the gastrovascular cavity. During regurgitation the hypostomal cone is prominent; seldom does the diameter of the mouth equal the diameter of the body; there is no or at most only a slight and transient increase in the diameter of the hypostome as a whole; there is no long continued period during which the mouth is open and increasing in diameter; (4) sloughing of ectodermal cells; (5) eversion of endoderm and sloughing of endodermal cells.

No attempt has been made to weight the several criteria of damage from a physiological point of view. Neither have we attempted to assess degrees of severity of any symptom—that is to say, for instance, the mouth is either open or closed; ectodermal cells are being lost or they are not.

Each abnormality when present is given a score of 1 and the total score at any time is considered a measure of the radiation injury at that time. Where appropriate, the graphs are plotted as average number of damage points per Hydra versus time.

All of the hydras used were from a clone culture maintained in the laboratory. Irradiation was done in the morning using animals fed the previous afternoon. Except as noted all irradiations were done in a pyrex glass dish of approximately 100 ml. capacity containing 50 ml. of standard saline (NaCl 0.1 gm. [.002 M]; $CaCl_2$ 0.024 gm. [.0002 M]; KCl 0.004 gm. [.00005 M], distilled H_2O to 1000 ml.). An aluminum plate 0.020 inch thick served as added filtration for the roentgen-ray beam and as a dish cover. Irradiation factors were 50 kv. constant potential, 50 ma. beryllium window tube, 3,000 r per minute; usually 15,000 r total dose. This dose was selected because it gave a high percentage of damage in controls and was not so disastrous as to completely overshadow any beneficial effects of treatment. Water cooling of the sample dish prevented more than 1 to 2 degree rise in temperature during irradiation. Within ten minutes after treatment the hydras were removed to individual dishes of unirradiated standard saline or saline plus the appropriate concentration of test material. Damage was recorded at fifteen minute intervals for the first hour; at thirty minute intervals from one to four hours and hourly thereafter. In no instance were the hydras exposed to irradiated fluids for more than ten minutes after irradiation.

Figures 1, 2, 3, and 4 are photographs showing the type of damage observed in hydras following 15,000 r of roentgen rays. In Figure 1 the body has contracted and the mouth is open. In this specimen there is not very much cell loss. Frequently an

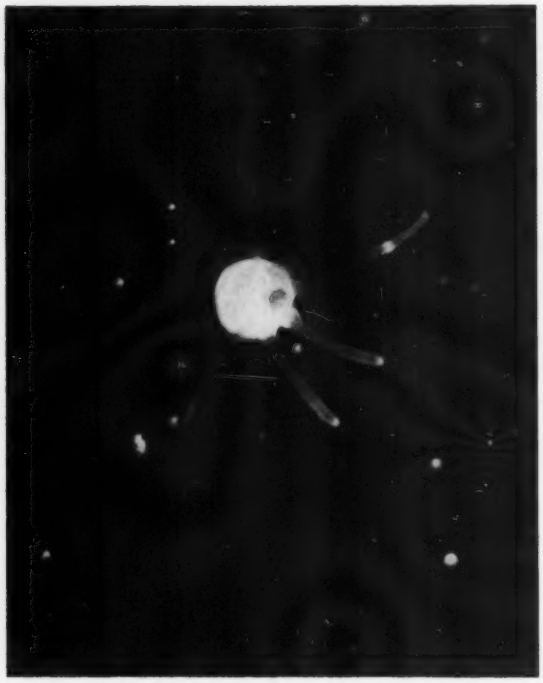

FIG. 1. The irradiated Hydra has contracted and the mouth is beginning to open.

animal similar to that of Figure 1 will be losing ectoderm before the mouth opens.

Figure 2 was made looking at the oral end of the longitudinal axis of a rather severely damaged animal. The outline of the mouth edge can be seen close to the point of attachment of the tentacles, which incidentally are not very severely damaged. A plug of endoderm from which cells are sloughing fills the mouth. Between the tentacles on the left and near their bases can be seen fragmentation of the ectoderm. An accumulation of cellular debris is apparent surrounding the point of attachment of the animal to the bottom of the observation dish. Figure 3 shows rather clearly the extensive disintegration of the endodermal plug. On rare occasions the mouth does not open and a plug of disintegrating endoderm will be extruded through an aperture in the pedal disc. Figure 4 is an excellent example of the loss of ectoderm.

Figure 5 is a composite curve from six experiments. The short horizontal lines at each time interval show the limits of the standard errors. From the figure it is obvious that 0.001 M Mg (used as $MgCl_2$) delays slightly the appearance of symptoms; damage is less marked, and recovery is more rapid and more nearly complete in a larger percentage of treated than in untreated animals.

Figure 6 shows for various times the percentage of animals in control and treated groups losing ectoderm and endoderm. There is also a marked difference in experimental and control groups when other individual symptoms of radiation damage are compared. If the magnesium concentration is raised to about 0.005 M toxic symptoms attributable to the magnesium intervene and the ultimate recovery from irradiation damage is not observed. Even at this toxic concentration, however, there is a pronounced delay in the development of symptoms characteristic of irradiation damage (see Fig. 7).

So far, we have not been able to demonstrate any difference in the action of $MgCl_2$ and $MgSO_4$. In general, we have used the chloride since all of the salts in standard

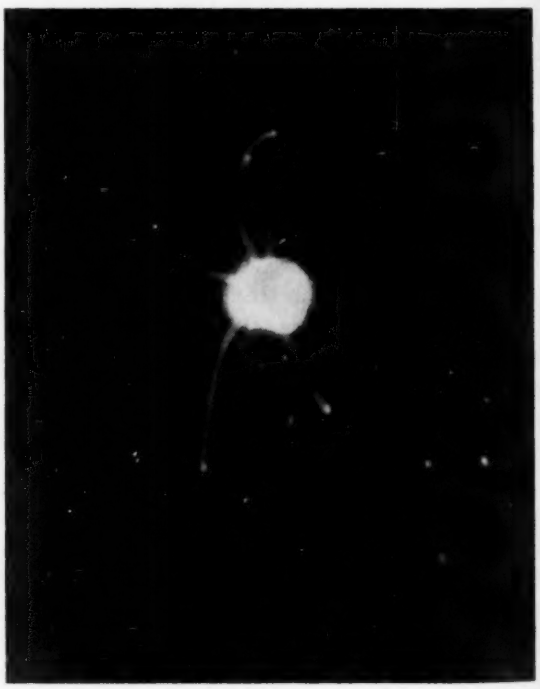

FIG. 2. Another irradiated Hydra showing a widely open mouth and loss of ectoderm. See text for further details.

Fig. 3. The mouth is greatly distended and is filled with a fragmenting plug of endoderm.

Fig. 4. Note the loss of ectoderm over the entire length of the Hydra. The animal is contracted and the mouth is slightly open (partially obscured by the foreground tentacle).

saline are chlorides and it is logical to avoid the introduction of different anions into the solutions.

The tissue disintegration characteristic of radiation damage suggested that calcium

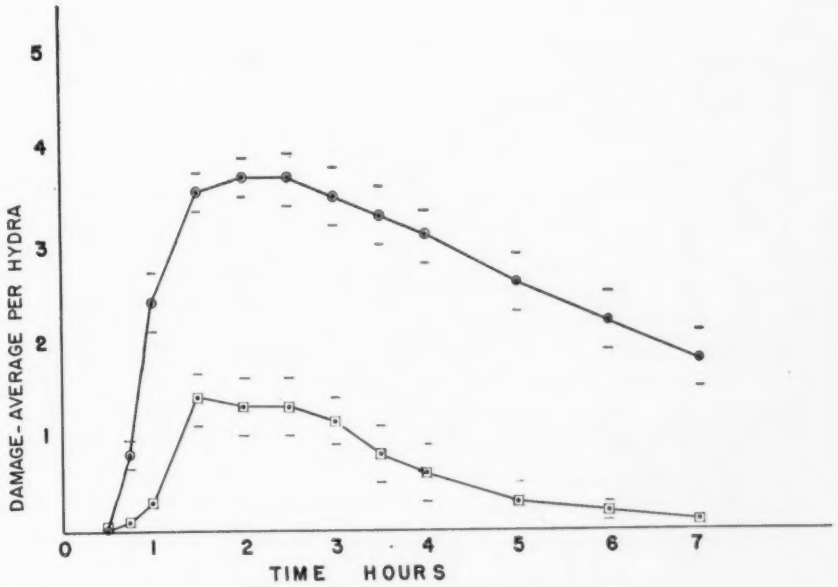

Fig. 5. Composite curve (6 experiments using 10 hydras in each) showing the protective effect of 0.00125 M magnesium. ⊙—Controls in magnesium free saline. ⊡—Experimentals in saline containing 0.00125 M Mg. The short horizontal lines at each time interval show limits of standard error.

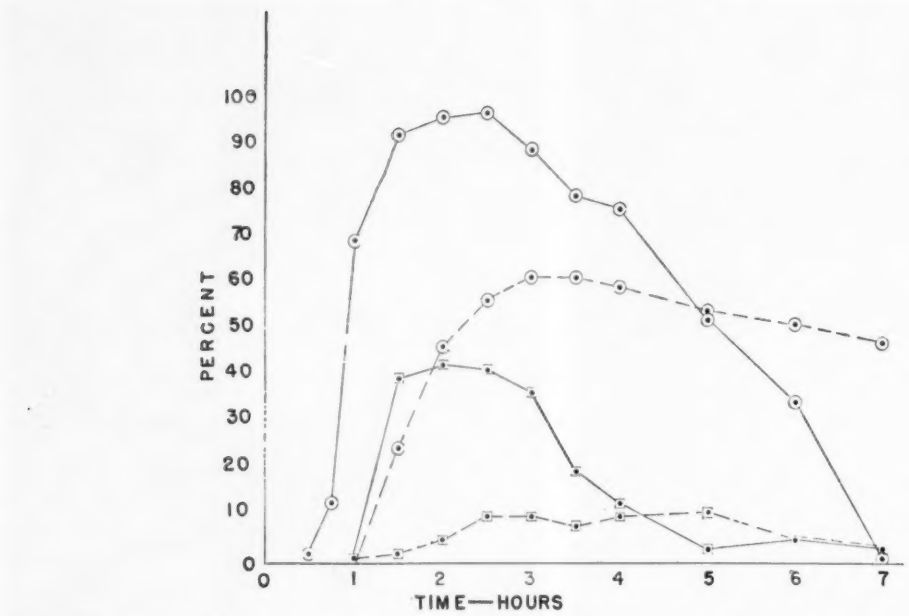

Fig. 6. Percentage of experimental and control animals losing endoderm and ectoderm as a function of time. ⊙—Loss of ectoderm, controls. ⊡—Loss of ectoderm, experimentals. ⊙- -⊙—Loss of endoderm controls. ⊡—⊡—Loss of endoderm, experimentals.

might effect some improvement. Experiments covering quite a range of calcium concentrations failed to show any helpful effect of added amounts of this ion. Typical results are illustrated in Figure 8.

Although calcium alone does not seem to

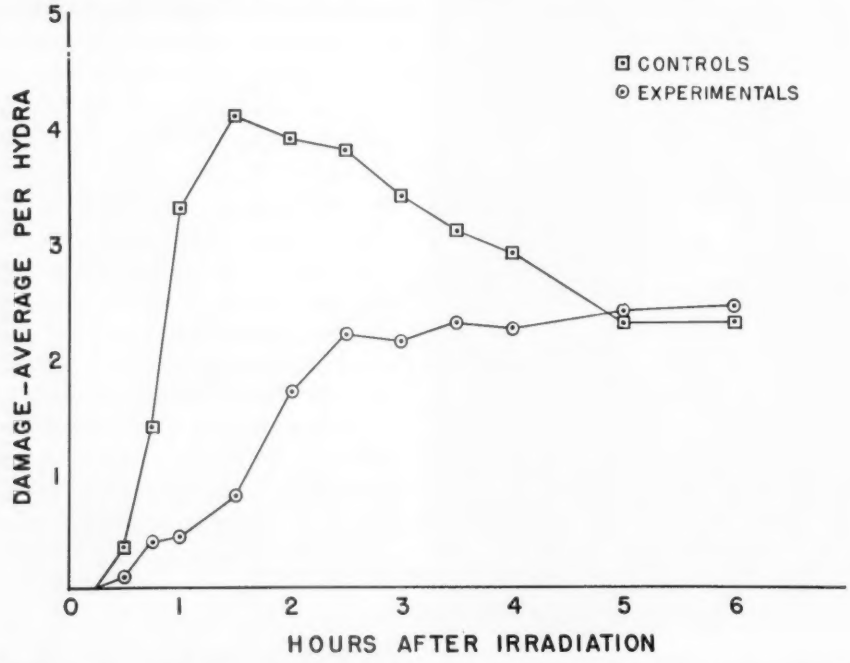

Fig. 7. Although 0.0025 M magnesium is itself toxic the radiation damage is slower in development than in animals not treated with magnesium.

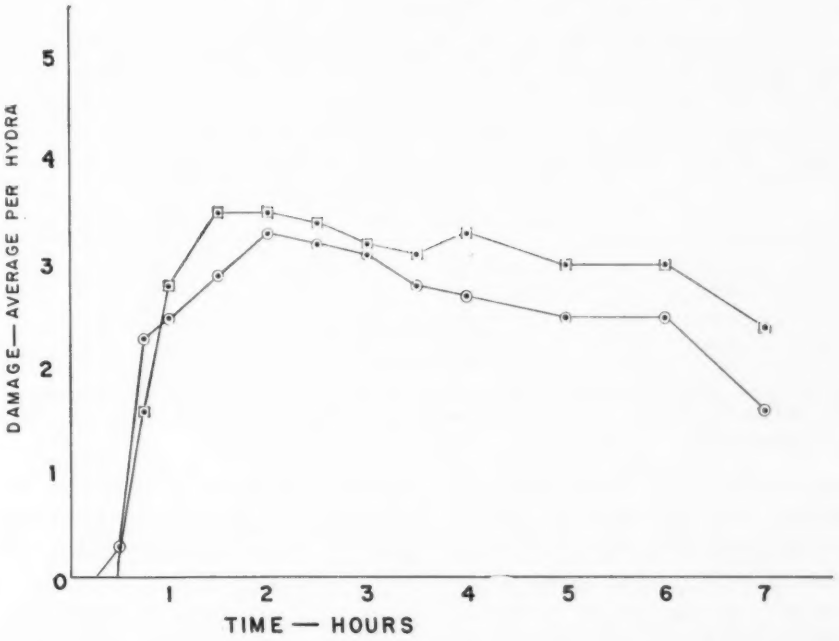

Fig. 8. There is no protection afforded by increasing the calcium of the saline. ⊙—Controls. ⊡—Experimentals.

have any protective action there does appear to be some relationship between the calcium and magnesium content of the saline and protective action. Some data on this question are presented in Figure 9 and Table 1. The results shown in Figure 9 were obtained as follows: Fifty hydras were irradiated and 20 irradiated animals were

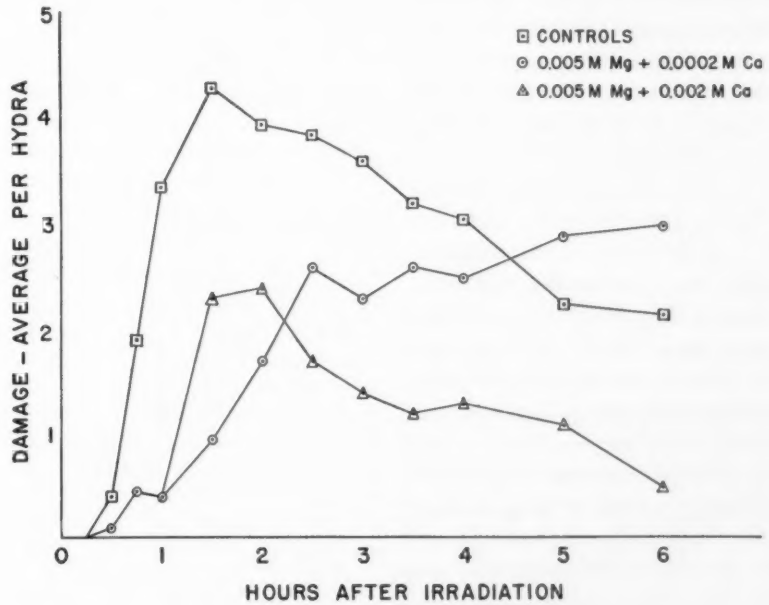

Fig. 9. Showing that there is a relationship between the calcium and magnesium content of the saline used post-irradiation and the protective action of magnesium.

TABLE I

RELATIONSHIP OF Mg AND Ca CONCENTRATION TO DAMAGE SCORE*

No. Hydra	Mg	Ca	Mg/Ca	Experimental				Control			
				Max. damage	Time hr.	Min. damage	Time hr.	Max. damage	Time hr.	Min. damage	Time hr.
50	.005	.002	2.5	3	2	0.6	6	4.1	2	2.5	6
20	.0016	.0002	8	3.9	2.5	0.4	7	4.8	2.5	2.3	7
20	.00125	.0001	12.5	1.3	1.5	0.5	6	4.4	2.5	3.6	6
10	.00125	.00005	25	2.1	2	0.8	5	4.2	2	3.4	6

* Maximum and minimum damage expressed as average score per Hydra. Time is the period required to reach maximum damage and recover to minimum score. Experimental animals treated immediately post-irradiation with Mg+Ca at indicated concentrations. Controls not exposed to magnesium.

placed, immediately after irradiation, in standard saline and allowed to remain therein for the entire observation period. Thirty animals were placed in saline which was 0.005 M in magnesium and 0.0002 M in calcium (solution 1). At the end of one hour 15 animals were transferred from solution 1 to a solution 0.005 M in Mg and 0.002 M in Ca (solution 2) and the remaining 15 were left in solution 1. From Figure 9, the lack of protection afforded by the 0.005 M Mg+0.0002 M Ca is obvious while the protective effect of the 0.005 M Mg+ 0.002 M Ca is apparent. Since Ca ion alone shows no protective action against irradiation damage it is quite likely that in this experiment the Ca is acting to offset toxic properties of Mg and is in no way acting directly to repair irradiation ravages.

Although over the concentration range used in these experiments there is a definite requirement that both calcium and magnesium be present in the solution the relationship both as regards Mg/Ca ratio and absolute concentrations of the ions may be varied over a considerable range without destroying the effectiveness of the magnesium (see Table 1).

Survival data for twenty-four and forty-eight hours following 15,000 r of roentgen radiation and for twenty-four hours following 25,000 r are shown in Tables II and III respectively. In recording the results shown in Table II survival is based on our estimate of the ability of the hydra to capture and ingest food when it is offered. In Table III survival means only the presence of an organized mass of tissue which will respond to mechanical stimulation as contrasted with an inert mass of debris. In both instances the animals were treated with 0.00125 M magnesium after irradiation.

A series of experiments indicates that the

TABLE II

SURVIVAL AT 24 AND 48 HOURS FOLLOWING 15,000 r OF ROENTGEN RADIATION

(See Text for Criterion of Survival)

Experimental (.00125 M Mg)		Controls (Saline)	
No. treated	No. survivals	No. treated	No. survivals
24 HOURS			
10	10	10	5
10	10	10	6
10	10	10	6
10	10	10	7
10	9	10	3
50	49 (98%)	50	27 (54%)
48 HOURS			
10	6	10	4
10	7	10	5
10	10	10	6
10	6	10	2
40	29 (72%)	40	17 (42%)

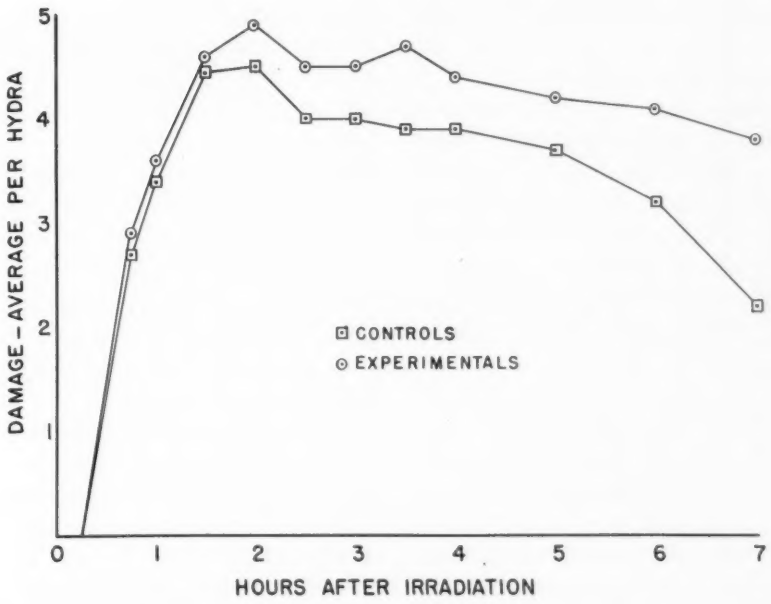

Fig. 10. This curve shows no protective effect of a saline equal in ionic strength to the Mg saline but containing no magnesium.

protective effect of Mg is not a function of the ionic strength of the solution. Figure 10 shows the results when irradiated hydras are placed in a solution of NaCl+KCl+$CaCl_2$ equal in ionic strength to standard saline plus 0.00125 M magnesium.

No protection was obtained in solutions containing a wide range of concentrations of Fe, Ba, Be, Mn, Ca and K.

In a recent report[1] we have shown that saline irradiated in contact with air is deleterious to Hydra. In order to eliminate any possible contribution of an irradiated air overlay a series of three experiments using 10 hydras in each was made. A dish completely filled with saline was covered with a glass plate in such a manner that no air was enclosed between cover and saline surface. Hydras irradiated with 15,000 r under such conditions were placed in unirradiated saline and in 0.00125 M Mg in saline. The results are shown in Figure 11. The curve is in all respects similar to others found when irradiation was performed in the presence of air.

Table III

Survival at 24 hours following 25,000 r of roentgen radiation
(See Text for Criterion of Survival)

Experimental		Controls	
No. treated	No. survivals	No. treated	No. survivals
6	6	6	5
10	9	10	5
10	10	5	1
10	9	10	3
10	5	10	2
10	8	10	4
56	47	51	20

Hydras have been treated for eighteen hours before irradiation with 0.00125 M magnesium. When such animals are removed immediately post-irradiation to Mg free saline, damage is equal to that observed in those animals never exposed to post-treatment magnesium. Transfer after irradiation to saline containing 0.00125 M Mg gives the same degree of protection seen in animals which had received no pre-irradiation magnesium. Treatment with 0.00125 M Mg ten minutes pre-irradiation and during irradiation and immediate

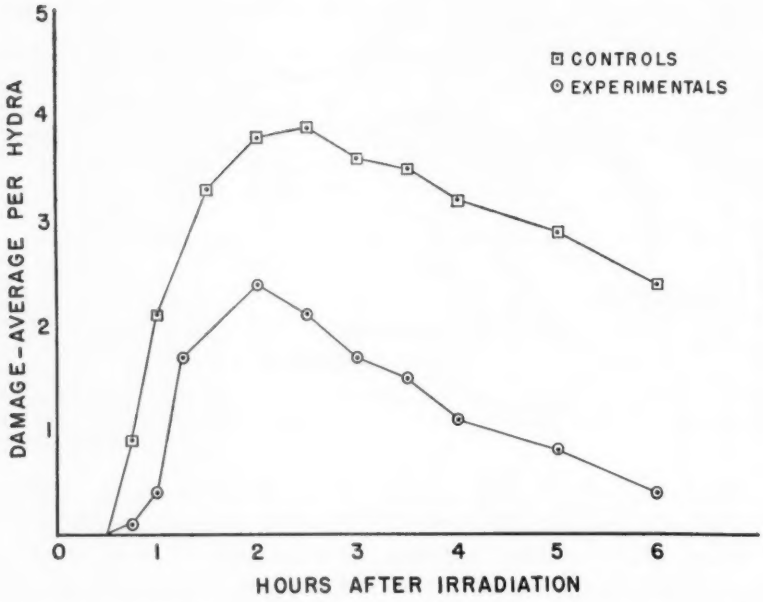

FIG. 11. These curves obtained from hydras irradiated in a dish without an air overlay are essentially similar to those found when an air overlay is present during irradiation.

transfer to magnesium free saline after irradiation is followed by damage equal to that seen when no magnesium is used.

DISCUSSION

There are several physiological implications of the results outlined above. Loss of ability to adhere to surfaces can mean a cessation of secretory action or an abnormal functioning of the glandular cells of the pedal disc. It is not unusual to find, in a normal culture, that many if not most of the animals are not attached to the bottom or sides of the culture dish but are attached to the surface film of the culture fluid. In general these surface-attached organisms have a gas bubble formed in the mucoid secretion of the pedal disc and their position may be due to the buoyancy of this bubble rather than physical attachment to the surface film. The complete lack of attachment to any surface is, however, entirely abnormal in a vigorous culture. At present we have no data concerning the condition of other secretory cells in the body.

One of the most constant characteristics of Hydra is the rapidity and degree of contraction of body and tentacles in response to mild mechanical stimulation. Irradiation brings about a marked sustained contraction of the body and stalk of the animal. In general the tentacle contraction is much less marked and in some cases there even appears to be a considerable degree of relaxation of this organ. The "short body" of irradiated hydras is apparently less responsive to mechanical stimulation than is the extended body. This condition may be more apparent than real since the chief visual reaction to stimulation is a shortening of the body, but body length in the irradiated forms has already reached an essentially minimum value.

Although the degree of response to stimulation is difficult to evaluate there is no mistaking the complete loss of ability to extend the body to normal proportions. This condition implies either a severe dysfunction of the individual epitheliomuscular cell or a breakdown in the communication mechanism responsible for coordinated action directed towards a lengthening of the body and stalk. The appearance of the strongly contracted body is suggestive of a tetanic state in which the contraction of

the longitudinal epitheliomuscular cells override that of the circular layer. As can be seen from Figures 2 and 3, the mouth in the severely damaged animal is greatly distended and often filled with a plug of endoderm which protrudes beyond the anterior limit of the mouth periphery. In not a few instances the anterior part of the body appears to be pulled down over the endoderm much as one might peel a banana. It is not essential that muscle cells contract in order for a shortening of the body to occur. If a simultaneous flaccidity develops in both longitudinal and circular muscles, and any structual rigidity of cementing substances is lost, surface forces acting on the mass would tend towards the development of sphericity even in the unhomogeneous mixture constituting the Hydra body. It is generally agreed that anesthetics induce a flaccid state in muscles. When anesthetics such as $MgSO_4$ or urethane are administered to Hydra the body and tentacles stretch to a length in excess of that found in the excitable animal. It would seem therefore that a relaxation of the muscle cells in Hydra leads to an extension of the body rather than the marked contraction which follows a dose of 15,000 r of roentgen rays.

Although we have not observed any sequence in the appearance of symptoms when the group as a whole is considered, there are a few events which are connected, although probably not as cause and effect. For example, endoderm is not lost (except in a few isolated instances) before the mouth is open because the mouth is the only universally present route by which material can leave the gastrovascular cavity. Also, in general, there is no massive ectodermal loss until after the body is sharply contracted. There is a change in the character of the intercellular cement substance which, through its disruption of tissue organization, could allow surface forces to accelerate the trend towards sphericity, as indicated by a shortening of the body. Such tissue disintegration does not, however, occur in massive form until after the shortening process and the exaggerated distortion of the mouth is well advanced, but perhaps not completed.

The effect of anesthetics, the time relationships between contraction and general tissue disintegration and the general morphology of the contracted animal support the concept of a tetanic state of the epitheliomuscular cells. If the assumption of a tetanic condition is essentially true one may picture the vertically arranged portion of the musculature as undergoing a contraction severe enough to break part of the attachment of endoderm to ectoderm and draw the outer layer of the body toward the foot. Such an action assumes some more or less widespread defect in the attachment of endoderm and ectoderm. Such a defect is strongly indicated by the manner in which cells are lost from ectoderm and apparently the same mechanism operates in the endoderm and endoderm-ectoderm contact area. When a small portion of the intact ectoderm of a normal Hydra is pulled away from the body a cone is formed which has an appreciable degree of elasticity. Contrary to the fairly rapid return of a displaced portion of normal ectoderm, the ectoderm of irradiated animals (some 30–45 minutes after irradiation) is entirely unelastic. Long strings of sticky material containing many cells may be pulled from the irradiated body. The debris shown at the base of the Hydra in Figure 2 is a collection of this mucilaginous material which has sloughed off and fallen to the bottom of the dish.

We attribute the observed loss of cells to an alteration of the intercellular binding substance—loosening followed by detachment from the body—induced by the action of the radiation on the intercellular cement substance (mesoglea). A role of primary importance may, however, be played by the irradiated cell in that through some mechanism the cell-mesoglea relationship is destroyed by changes initiated by the irradiated (damaged) cell. In this event the loss of elasticity of the ectodermal layer is still due to change in the binding material but the event bringing about the change is

initiated by an irradiated body cell and not because of the absorption of externally applied energy by the cement substance.

Magnesium has anesthetic properties demonstrable in practically every species of animal. Anesthetic concentration varies from species to species and cannot be predicted with any degree of accuracy. If by anesthesia one means the loss of readily observable reaction to commonly applied stimulants then none of the concentrations of magnesium used in this study can be so classified. If by anesthesia one implies some subtle alteration in the biochemistry of the individual cell then because of the extreme technical difficulties involved we have no information on the subject. Suffice it to say that we have seen nothing to suggest that anesthesia is contributing to the observed results.

SUMMARY

1. Magnesium in appropriate amounts has a marked effect in alleviating and preventing the damage caused in Hydra by 15,000 r of roentgen rays.

2. The advantages of magnesium are apparent only when the material is used post-irradiation. There is no effect of pre-irradiation treatment and no synergistic action between pre- and post-irradiation use of magnesium.

3. Magnesium is the only ion of those studies (Fe, Mn, Be, Ba, Ca, K and Mg) showing any protective effect.

4. Mg/Ca ratio may be varied over a wide range without destroying the beneficial effects of the magnesium.

5. Suggestions are presented relative to the physiological implications of the observed symptoms and the biological mechanism responsible for their appearance.

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THE AMERICAN JOURNAL OF ROENTGENOLOGY, RADIUM THERAPY AND NUCLEAR MEDICINE

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Fifty-sixth Annual Meeting: Palmer House, Chicago, Illinois, September 20–23, 1955.

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Representatives on National Committee on Radiation Protection: Edith H. Quimby, New York, N. Y., Theodore P. Eberhard, Philadelphia, Pa.

Thirty-seventh Annual Meeting: Shoreham Hotel, Washington, D. C., April 21–23, 1955.

EDITORIAL

THE FIFTY-FIFTH ANNUAL MEETING OF THE AMERICAN ROENTGEN RAY SOCIETY

AS WAS anticipated, the Fifty-fifth Annual Meeting of the American Roentgen Ray Society, which was held at the Shoreham Hotel in Washington, D. C., September 21 to 24, 1954, was a splendid one in all respects. The program which had been arranged by President-Elect Joshua C. Dickinson and his Committee was most interesting and instructive.

The scientific session of the meeting was opened on Tuesday morning by the Call to Order by President Harry M. Weber, and the Address of Welcome to the Society was delivered by Dr. P. A. McClendon, President of the Medical Society of the District of Columbia, Washington, D. C. His excellent address was a fine prologue to the installation of President-Elect Joshua C. Dickinson as President. President Dickinson chose as the subject of his Inaugural Address "The Art of Clinical Radiology" and perhaps there is no one in the Society who is better equipped to speak on this subject by virtue of his constant practice of the art of clinical radiology. It was a stimulating discussion which attracted the attention of all those in attendance. In the rapid advances that are taking place in the technical aspects of radiology, the art of clinical radiology finds itself in what might be called spirited competition with technical advances, and too frequently the radiologist in his efforts to arrive at a diagnosis forgets the art of the practice of radiology. President Dickinson made a special plea to the radiologist to remember that there is and still remains an art in the practice of all branches of medicine, and he emphasized the very great importance of practicing in the radiological departments as well as in the private offices of radiology the art of clinical radiology. In listening to President Dickinson one could not fail to recall one of the great masters of the art in the practice of medicine, namely Sir William Osler himself. Those who will profit from having listened to so splendid an address will be grateful to President Dickinson for having chosen the subject he did.

President Dickinson's address was followed by excellent discussions dealing with the diagnostic aspects of radiology as well as with the therapy and physics of radiology, radioactive isotopes and chemotherapy.

One of the important symposiums dealt with "Carcinoma of the Lung." Dr. M. C. Sosman of Boston, Massachusetts, was moderator for this symposium and he had enlisted the aid of a splendid group of participants. With the increasing incidence of carcinoma of the lung, this symposium dealt with timely topics in which roentgenologists must interest themselves if advances are to be made in the recognition and cure of carcinoma of the lung.

Another symposium of great interest was one dealing with "Blood Dyscrasias, Lymphoma-Leukemia Group." Dr. H. Dabney Kerr of Iowa City, Iowa, was the moderator of this symposium in which was discussed not only the treatment of the malignant lymphomas with conventional roentgen therapy but the use of radioactive isotopes as well as the chemotherapeutic aspects in dealing with the lymphomas and blood dyscrasias.

Dr. Edith H. Quimby of New York City was moderator of an excellent symposium dealing with the "Uses of Radioactive Isotopes in Medical Diagnosis and Research."

Another outstanding symposium, of which Dr. E. B. D. Neuhauser of Boston was the moderator, considered the subject of "Neonatal Respiratory Distress Syndromes," and a final symposium that evoked considerable interest and discussion was one on the subject of "Inflammatory Lesions of the Gastrointestinal Tract" which was moderated by Dr. Fred J. Hodges of Ann Arbor, Michigan.

The Caldwell Lecture was given on Tuesday evening by Dr. Edward L. Jenkinson, Professor and Chairman of the Department of Radiology, Northwestern University Medical School, and Director of the Department of Radiology of St. Luke's Hospital, Chicago, Illinois, who chose as the topic of his lecture "The Pyloric Antrum of the Stomach." Dr. Jenkinson's well known knowledge of the roentgenology of the gastrointestinal tract pre-eminently fitted him for such a discussion. He gave not only the historical background of our knowledge of the pyloric antrum but he stressed the various phases of the advances in the roentgenologic conception of the physiologic functioning of the pyloric antrum as well as its various pathologic conditions. Needless to say, Dr. Jenkinson's address was most interesting and stimulating.

Dr. Harry M. Weber returned as Director of the Instruction Courses and these courses under his directorship as usual offered a variety of interesting subjects and attracted capacity groups of individuals.

The Scientific Exhibits at the Washington meeting far surpassed those of many previous meetings not only in the quality of the exhibits themselves but in the variety of subjects dealing with all phases of radiology, and the attractive manner in which the exhibits were displayed was a source of comment among interested observers. Elsewhere in this issue of the Journal will be found a comprehensive report of the scientific exhibits.

The Commercial Exhibits, too, were exceptional not only in the number of exhibits but in their quality and character. The available space for the commercial exhibits at The Shoreham in close proximity to all other activities of the meeting offers a splendid opportunity for the manufacturers to display their latest equipment in an orderly and attractive manner.

As is usual, the scientific program of the meeting occupied most of each day. However, the Committee on Local Arrangements under the chairmanship of Dr. Ralph M. Caulk had arranged many interesting social events. On Monday preceding the beginning of the scientific sessions the Annual Golf Tournament was held at the Manor Country Club. Competition was for the Willis F. Manges Trophy as well as for the Exhibitors Trophy. The golf tournament was followed by the golf dinner at the same club. On Thursday evening was held the Annual Banquet of the Society. On this occasion President Dickinson made the presentation of awards to the scientific exhibitors whose exhibits had been chosen as most outstanding. The banquet was followed by enjoyable entertainment and dancing.

Washington with its unusual number of historical buildings, museums and libraries and many other features of great interest lends itself admirably to the extracurricular enjoyment of a scientific meeting. A splendid program of luncheons and trips for the visiting ladies had been arranged by the local Ladies Committee under the chairmanship of Mrs. Ralph M. Caulk and to her and her committee the Society is grateful.

The Society also wishes to express its thanks and appreciation to the Convention and Tourist Bureau of the Washington Board of Trade and to its Executive Director, Mr. Clarence A. Arata, for the highly efficient and pleasant manner in which the registration was carried out. The registration was the largest the Society has ever had at one of its annual meetings —a total of 2,060, consisting of 283 members, 959 guests, 425 commercial exhibitors and 393 ladies.

To Mr. L. Gardner Moore, Manager

of The Shoreham, and his staff, the Society desires to express its gratitude and thanks for the manner in which they carried out all the details of the arrangements that were made both by the Local Committee and by the Society.

From one and all there was nothing but the highest praise for the Washington meeting and President Dickinson may look back with satisfaction upon a splendid meeting well conducted in all its phases.

SOCIETY PROCEEDINGS, CORRESPONDENCE AND NEWS ITEMS

MEETINGS OF ROENTGEN SOCIETIES*

United States of America

American Roentgen Ray Society
Secretary, Dr. Barton R. Young, Germantown Hospital, Philadelphia 44, Pa. Annual meeting: Palmer House, Chicago, Ill., Sept. 20–23, 1955.

American Radium Society
Secretary, Dr. R. E. Fricke, Mayo Clinic, Rochester, Minn. Annual meeting: Shoreham Hotel, Washington, D. C., April 21–23, 1955.

Radiological Society of North America
Secretary, Dr. D. S. Childs, 713 E. Genesee St., Syracuse 2, N. Y. Annual meeting: Biltmore Hotel, Los Angeles, Calif., Dec. 5–10, 1954.

American College of Radiology
Executive Secretary, William C. Stronach, 20 N. Wacker Drive, Chicago 6, Illinois.

Section on Radiology, American Medical Association
Secretary, Dr. T. Leucutia, Harper Hospital, Detroit 1, Mich.

Fifth Inter-American Congress of Radiology
Secretary-General, Dr. Eugene P. Pendergrass, 3400 Spruce St., Philadelphia 4, Pa. Meets at Shoreham Hotel, Washington, D. C., April 24–29, 1955.

Alabama Radiological Society
Secretary, Dr. J. A. Meadows, Jr., Medical Arts Bldg., Birmingham 5, Ala. Meets time and place Alabama State Medical Association.

Arizona Radiological Society
Secretary, Dr. R. Lee Foster, 507 Professional Bldg., Phoenix, Ariz. Two regular meetings a year. The annual meeting at time and place of State Medical Association and interim meeting six months later.

Arkansas Radiological Society
Secretary, Dr. J. A. Norton, 843 Donaghey Bldg., Little Rock, Ark. Meets every three months and also at time and place of State Medical Association.

Atlanta Radiological Society
Secretary, Dr. Albert A. Rayle, Jr., 478 Peachtree St., N.E., Atlanta, Ga. Meets monthly, except during three summer months, on second Friday evening.

Brooklyn Roentgen Ray Society
Secretary, Dr. J. J. Daversa, 345 75th St., Brooklyn, N. Y. Meets monthly fourth Tuesday, October through April.

Buffalo Radiological Society
Secretary, Dr. Clayton G. Weig, 135 Linwood Ave., Buffalo, N. Y. Meets second Monday evening each month, October to May inclusive.

Central New York Roentgen Ray Society
Secretary, Dr. Dwight V. Needham, 608 E. Genesee St., Syracuse N. Y. Meets January, May, November.

Central Ohio Radiological Society
Secretary. Dr. F. A. Riebel, 15 West Goodale St., Columbus, Ohio. Meets at 6:30 P.M. on second Thursday of October, December, February, April, and June at Columbus Athletic Club, Columbus, Ohio.

Chicago Roentgen Society
Secretary, Dr. E. Burns Lewis, 670 N. Michigan Ave., Chicago 11, Ill. Meets second Thursday of each month, October to April inclusive at the University Club.

Cleveland Radiological Society
Secretary, Dr. Mortimer Lubert, 10515 Carnegie Ave., Cleveland 6, Ohio. Meetings at 6:45 P.M. on fourth Monday of each month from October to April.

Colorado Radiological Society
Secretary, Dr. S. A. Patterson, Larimer County Hospital, Fort Collins, Colo. Meets third Friday of each month at University of Colorado Medical Center or at Denver Athletic Club.

Connecticut Valley Radiologic Society
Secretary, Dr. B. B. Alicandri, 20 Maple St., Springfield, Mass. Meets second Friday October and April.

Dallas-Fort Worth Radiological Club
Secretary, Dr. O. H. Grunow, 650 Fifth Ave., Fort Worth, Texas. Meets monthly, third Monday, at Greater Fort Worth International Airport at 6:30 P.M.

Detroit Roentgen Ray and Radium Society
Secretary, Dr. E. F. Lang, Harper Hospital, Detroit, Mich. Meets monthly first Thursday, Oct. through May, at David Whitney House, 4421 Woodward Ave., at 6:30 P.M.

East Bay Roentgen Society
Secretary, Dr. Dan Tucker, 434 30th St., Oakland 9, Calif. Meets first Thursday each month at Peralta Hospital, Oakland.

Florida Radiological Society
Secretary, Dr. J. T. Shelden, Box 1021, Lakeland, Fla. Meets twice annually, in the spring with the annual State Society meeting, and in the fall.

Georgia Radiological Society
Secretary, Dr. Herbert M. Olnick, 417 Persons Bldg., Macon, Ga. Joint meeting with Florida State Medical Association, November, 1954.

Greater Miami Radiological Society
Secretary, Dr. R. D. Shapiro, 541 Lincoln Rd., Miami Beach, Fla. Meets monthly at various South Florida Hospitals.

Houston Radiological Society
Secretary, Dr. Harry Fishbein, 324 Medical Arts Bldg., Houston 2, Texas. Meets fourth Monday each month at Hermann Hospital.

Idaho State Radiological Society
Secretary, Dr. Alfred M. Stone, St. Lukes Hospital, Boise, Idaho. Meets annually at same time as Idaho State Medical Association.

Illinois Radiological Society
Secretary, Dr. Stephen L. Casper, 1101 Maine St., Quincy, Ill. Meets three times a year.

Indiana Roentgen Society
Secretary, Dr. John A. Robb, 238 Hume-Mansur Bldg., Indianapolis 4. Meets first Sunday in May and during fall meeting of Indiana State Medical Association.

Iowa Radiological Society
Secretary, Dr. James T. McMillan, 1104 Bankers Trust Bldg., Des Moines, Iowa. Luncheon and business meeting during annual session of Iowa State Medical Society. The scientific section is held in the autumn.

Kansas Radiological Society
Secretary Dr. A. M. Cherner, Hays, Kansas. Meets in spring with State Medical Society, and in winter on call.

Kentucky Radiological Society
Secretary, Dr. David Shapiro, 323 East Chestnut St., Louisville 2, Ky. Meets monthly on second Friday at Seelbach Hotel, Louisville.

Kings County Radiological Society
Secretary, Dr. Solomon Maranov, 1450 51st St., Brooklyn 19, N. Y. Meets Kings County Med. Soc. Bldg. monthly on fourth Thursday, October to May, 8:45 P.M.

Los Angeles Radiological Society
Secretary, Dr. Oscar Harvey, 3741 Stocker St., Los Angeles 8, Calif. Meets second Wednesday each month at Los Angeles County Medical Association Building, Los Angeles.

* Secretaries of societies are requested to send timely information promptly to the Editor.

Maine Radiological Society
Secretary, Dr. Jack Spencer, Maine General Hospital, Portland 4, Maine. Meets in early spring, June and fall.

Maryland Radiological Society
Secretary-Treasurer, Dr. Paul W. Roman, 1810 Eutaw Place, Baltimore 17, Maryland.

Miami Valley Radiological Society
Secretary, Dr. G. A. Nicoll, 134 Apple St., Dayton, Ohio. Meets second Friday of fall and winter months.

Mid-Hudson Radiological Society
Secretary, Dr. J. W. Walton, Horton Memorial Hospital, Middletown, N. Y. Meets 8:30 P.M., fourth Tuesday each month, September to May.

Milwaukee Roentgen Ray Society
Secretary, Dr. R. W. Byrne, 3321 N. Maryland Ave., Milwaukee 11, Wis. Meets monthly on fourth Monday at University Club.

Minnesota Radiological Society
Secretary, Dr. John R. Hodgson, Mayo Clinic, Rochester, Minn. Meets three times annually, once at time of State Med. Assn., and in spring and fall.

Mississippi Radiological Society
Secretary, Dr. John W. Evans, 117 N. President St., Jackson, Miss. Meets third Thursday of each month at the Rotisserie Restaurant at 6:30 P.M.

Montana Radiological Society
Secretary, Dr. Grant P. Raitt, Suite 413 Medical Arts Bldg., Billings, Montana. Meets at least once a year.

Nassau Radiological Society
Secretary, Dr. Alan E. Baum, Hicksville, N. Y. Meets second Tuesday of the month in February, April, June, October and December.

Nebraska Radiological Society
Secretary, Dr. J. F. Kelly, Jr., 816 Medical Arts Bldg., Omaha, Nebr. Meets third Wednesday of each month at 6 P.M. in Omaha or Lincoln.

New England Roentgen Ray Society
Secretary, Dr. Stanley M. Wyman, Massachusetts General Hospital, Boston, Mass. Meets monthly on third Friday, Harvard Club.

New Hampshire Roentgen Ray Society
Secretary, Dr. A. C. Johnston, Elliott Community Hospital, Keene, N. H. Meets four to six times yearly.

New York Roentgen Society
Secretary, Dr. Sidney Rubenfeld, 477 First Ave., New York 16, N. Y. Meets monthly on third Monday, New York Academy of Medicine, at 8:30 P.M.

North Carolina Radiological Society
Secretary, Dr. W. C. Sternbergh, Charlotte Memorial Hospital, Charlotte, N. C. Meets in May and October.

North Dakota Radiological Society
Secretary, Dr. C. O. Heilman, 807 Broadway, Fargo. Meetings by announcement.

North Florida Radiological Society
Secretary, Dr. Ivan Isaacs, 1645 San Marco Blvd., Jacksonville, Florida. Meets quarterly in March, June, September and December.

Northeastern New York Radiological Society
Secretary, Dr. D. H. Baxter, Albany Hospital, Albany, N. Y. Meets in Albany area on second Wednesdays of October, November, March and April.

Northern California Radiological Society
Secretary, Dr. H. B. Stewart, 2920 Capitol Ave., Sacramento, Calif. Meets at dinner last Monday of each month, September to June.

Ohio State Radiological Society
Secretary, Dr. M. M. Thompson, Jr., 319 Toledo Medical Bldg., Toledo 2, Ohio.

Oklahoma State Radiological Society
Secretary, Dr. John R. Danstrom, Medical Arts Bldg., Oklahoma City, Okla. Three regular meetings annually.

Oregon Radiological Society
Secretary, Dr. F. C. Shipps, 214 Medical-Dental Bldg., Portland 5, Oregon. Meets monthly from October to June on the second Wednesday of each month at 8:00 P.M. at the University Club.

Orleans Parish Radiological Society
Secretary, Dr. Joseph V. Schlosser, Charity Hospital, New Orleans 13, La. Meets first Tuesday of each month.

Pacific Northwest Radiological Society
Secretary, Dr. J. R. Raines, 214 Medical-Dental Bldg., Portland 5, Oregon. Meets annually in May.

Pacific Roentgen Society
Secretary, Dr. L. H. Garland, 450 Sutter St., San Francisco, Calif. Meets annually, during meeting of California Medical Association.

Pennsylvania Radiological Society
Secretary, Dr. J. M. Converse 416 Pine St., Williamsport. Next annual meeting at Berkshire Hotel, Reading, Penna., May 20 and 21, 1955.

Philadelphia Roentgen Ray Society
Secretary, Dr. H. M. Stauffer, Temple University Hospital, Philadelphia 40, Pa. Meets first Thursday of each month, at 5 P.M., from October to May in Thompson Hall, College of Physicians.

Pittsburgh Roentgen Society
Secretary, Dr. Donald H. Rice, Western Pennsylvania Hospital, Pittsburgh 24, Pa. Meets second Wednesday of month, October through June at Hotel Roosevelt.

Radiological Section, Baltimore Medical Society
Secretary, Dr. H. Leonard Warres, 2337 Eutaw Place, Baltimore 17, Md. Meets third Tuesday each month, September to May, inclusive.

Radiological Section, Connecticut Medical Society
Secretary, Dr. William A. Goodrich, 85 Jefferson St., Hartford 6, Conn. Meetings are held bi-monthly.

Radiological Section, Southern Medical Association
Secretary, Dr. Roy G. Giles, Temple, Texas.

Radiological Society of Greater Cincinnati
Secretary, Dr. Wm. R. Dickens, Cincinnati General Hospital, Cincinnati 29, Ohio. Meets monthly from September to June on first Monday of each month at 7:30 P.M. at the Cincinnati General Hospital.

Radiological Society of Hawaii
Secretary, Dr. H. C. Chang, 1282 Emma St., Honolulu 13, T. H. Meets third Monday evening of each month at designated hospitals.

Radiological Society of Kansas City
Secretary, Dr. Arthur B. Smith, 800 Argyle Bldg., Kansas City, Mo. Meets third Thursday of each month.

Radiological Society of Louisiana
Secretary, Dr. J. T. Brierre, 700 Audubon Bldg., New Orleans. Meets annually during Louisiana State Medical Society Meeting.

Radiological Society of New Jersey
Secretary, Dr. Carye-Belle Henle, 195 North 7th St., Newark, N. J. Meets at Atlantic City at time of State Medical Society and in November in Newark, N. J.

Radiological Society of Southern California
Secretary, Dr. George Jacobson, 1200 N. State St., Los Angeles 33, Calif.

Richmond County Radiological Society
Secretary, Dr. W. F. Hamilton, Jr., University Hospital, Augusta, Ga. Meets first Thursday of each month at various hospitals.

Rochester Roentgen Ray Society, Rochester, N. Y.
Secretary, Dr. Henry H. Forsyth, Jr., 40 Meigs St., Rochester, N. Y. Meets at 8:15 P.M. on the last Monday of each month, September through May, at Strong Memorial Hospital.

Rocky Mountain Radiological Society
Secretary, Dr. John H. Freed, 4200 East Ninth St., Denver 7, Colo. Meets at Shirley-Savov Hotel, Denver, Colo., Aug. 19–21, 1954.

St. Louis Society of Radiologists
Secretary, Dr. W. B. Seaman, 510 South Kingshighway, St. Louis 10, Mo. Meets fourth Wednesday each month, except June, July, August and September.

San Antonio-Military Radiological Society
Secretary, Dr. Hugo F. Elmendorf, Jr., 730 Medical Arts Bldg., San Antonio 5, Texas. Meets Brook Army Medical Center Officers Mess first Monday of each month.

San Diego Radiological Society
Secretary, Dr. C. W. Bruner, 2456 Fourth Ave., San Diego 1, Calif. Meets first Wednesday of each month at the University Club.

San Francisco Radiological Society
Secretary, Dr. I. J. Miller, 2680 Ocean Avenue, San Francisco 27, Calif. Meets quarterly.

Section on Radiology, California Medical Association
Secretary, Dr. H. R. Morris, 1027 "D" St., San Bernardino, Calif.

Section on Radiology, Medical Society of the District of Columbia
Secretary, Dr. John A. Long, 1801 K St., N.W., Washington 6, D. C. Meets Medical Society Library, third Wednesday of January, March, May and October at 8:00 P.M.

Section on Radiology, Illinois State Medical Society
Secretary, Dr. George E. Irwin, Jr., 703 N. East St., Bloomington, Ill.

Shreveport Radiological Club
Secretary, W. R. Harwell, 608 Travis St., Shreveport, La. Meets monthly on third Wednesday, at 7:30 P.M. September to May inclusive.

South Bay Radiological Society
Secretary, Dr. H. R. Berman, 309 St. Claire Bldg., San Jose, Calif. Meets second Wednesday of each month.

South Carolina Radiological Society
Secretary, Dr. William A. Klauber, Self Memorial Hospital, Greenwood, S. C. One meeting with South Carolina Medical Association in May, others arranged by President.

Tennessee Radiological Society
Secretary, Dr. G. K. Henshall, 311 Medical Arts Bldg., Chattanooga, Tenn. Meets annually at the time and place of the Tennessee State Medical Association.

Texas Radiological Society
Secretary, Dr. R. P. O'Bannon, 650 Fifth Ave., Fort Worth 4, Texas. Next meeting, Houston, Texas, January 21 and 22, 1955.

Tri-State Radiological Society
Secretary, Dr. S. N. Tager, 219 Walnut St., Evansville, Ind. Meets last Wednesday of Oct., Jan., March and May, 8:00 P.M. at Elks' Club in Evansville.

University of Michigan Department of Roentgenology Staff Meeting
Meets each Monday evening from September to June, at 7:00 P.M. at University Hospital.

University of Wisconsin Radiological Conference
Secretary, Dr. E. A. Pohle, 1300 University Ave., Madison, Wis. Meets first and third Thursdays 4:00 to 5:00 P.M., September to May, Service Memorial Institute.

Utah State Radiological Society
Secretary, Dr. Angus K. Wilson, 343 S. Main St., Salt Lake City 1, Utah. Meets fourth Wednesday in January, March, May, September and November at Holy Cross Hospital.

Virginia Radiological Society
Secretary, Dr. P. B. Parsons, Norfolk General Hospital, Norfolk, Va. Meets annually in October.

Washington State Radiological Society
Secretary, Dr. Eva L. Gilbertson, 1317 Marion St., Seattle 4, Wash. Meets fourth Monday of each month from September through May at 610 Pine St., Seattle.

West Virginia Radiological Society
Secretary, Dr. W. Paul Elkin, 515 Medical Arts Bldg., Charleston, W. Va. Meets concurrently with annual meeting of West Virginia State Medical Society; other meetings arranged by program committee.

Westchester Radiological Society
Secretary, Dr. M. G. Priestman New Rochelle Hospital, New Rochelle, N.Y. Meets on third Tuesday of January and October and on two other dates.

Wisconsin Radiological Society
Secretary, Dr. W. W. Moir, 309 Geele Ave., Sheboygan, Wis. Special meetings held during year; annual meeting each spring at Madison, Wis.

X-Ray Study Club of San Francisco
Secretary, Dr. Wm. W. Saunders, Veterans Administration Hospital, San Francisco 21, Calif. Meets monthly, third Thursday, at 7:45 P.M., Lane Hall, Stanford University Hospital.

Cuba, Mexico, Puerto Rico and Central America

Sociedad de Radiología y Fisioterapia de Cuba
President, Dr. J. Manuel Viamonte, Hospital Mercedes, Habana, Cuba. Meets monthly in Habana.

Sociedad Mexicana de Radiología, A. C.
Secretary General, Dr. Eugenio Toussaint, Calle del Oro No. 15, Mexico 7, D.F. Meets first Monday of each month.

Asociación Puertorriqueña de Radiología
Secretary, Dr. Rafael A. Blanes, Ave. Ponce de Leon 1175, Santurce, P. R.

Sociedad Radiológica Panameña
Secretary, Dr. L. Arrieta Sanchez, Apartado No. 86, Panama, R. de P. Meets monthly in a department of radiology of a local hospital, chosen at preceding meeting.

British Empire

Association of Radiologists of the Province of Quebec
Secretary, Dr. J.-P. Jean, 4039 Tupper St., Westmount, Que.

British Institute of Radiology Incorporated with the Röntgen Society
Ordinary meeting, on the Thursday preceding the third Friday, October to May at 8:15 P.M.
Medical Members' meeting, on third Friday in each month at 5:00 P.M., 32 Welbeck St., London, W 1.

Faculty of Radiologists
Honorary Secretary, Dr. J. F. Bromley, 45, Lincoln's Inn Fields, London, W.C.2, England.

Section of Radiology of the Royal Society of Medicine (Confined to Medical Members)
Meets third Friday each month at 4:45 P.M. at the Royal Society of Medicine, 1 Wimpole St., London.

Canadian Association of Radiologists
Honorary Secretary-Treasurer, Dr. D. L. McRae, Suite 305, 1555 Summerhill Avenue, Montreal 25, Que. Meetings January and June.

Section of Radiology, Canadian Medical Association
Secretary, Dr. C. M. Jones, Inglis St., Ext. Halifax, N. S.

Société Canadienne-Française d'Electro-Radiologie Médicales
General Secretary, Dr. Ls Ivan Vallée, 1058 rue St-Denis, Montreal 18, Canada. Meets third Saturday each month.

College of Radiologists (Australia and New Zealand)
Honorary Secretary, Dr. Alan R. Colwell, c/o British Medical Agency, 135 Macquarie St., Sydney, N.S.W.

South America

Asociacion Argentina de Radiologia
Secretary, Dr. Lidio G. Mocsa, Avda. Gral. Paz 151, Córdoba, Argentina. Meetings held monthly.

Sociedad Argentina de Radiologia, Junta Central, Buenos Aires
Secretary, Dr. Oscar F. Noguera, Santa Fe 1171, Buenos Aires. Meetings are held monthly.

Sociedad Argentina de Radiologia, Filial del Litoral, Sede, Rosario
President, Dr. Francisco P. Cifarelli. Meets monthly second Wednesday, 19 ha 663 Italia St., Rosario, Santa Fe.

Sociedad Argentina de Radiologia, Filial del Sur, Sede, La Plata
President, Prof. Dr. Jose P. Uslenghi, La Plata. Meets monthly.

Sociedad Argentina de Radiologia, Filial del Centro Sede, Cordoba
President, Prof. Dr. David L. Caro, Corro 86, Cordoba. Meets monthly.

Sociedad Argentina de Radiologia, Filial del Norte, Sede, Tucuman
President, Dr. Julio Mendez Valladares, Rivadavia 358, Tucuman. Meets monthly.

Sociedad Argentina de Radiologia, Filial de Cuyo Sede, Mendoza.
President, Dr. J. A. Orfila, Hospital Central, Mendoza. Meets monthly.

Sociedade Brasileira de Radiologia Medica
Secretary, Dr. Nicola Caminha, Av. Mem de Sa, Rio de Janeiro, Brazil. Meets monthly, except during January, February and March.

Sociedade Brasileira de Radioterapia
Secretary, Dr. Oscar Rocha von Pfuhl, Av. Brigadeiro Luiz Antonio, 644 São Paulo, Brazil. Meets monthly on second Wednesday at 9:00 P.M. in São Paulo at Av. Brigadeiro Luiz Antonio, 644.

Sociedad Colombiana de Radiologia
Secretary, Dr. Luis E. Lozano B., Carrera 12 No. 20–69, 6° piso, Bogota, Colombia. Meets last Thursday of each month.

Sociedad Peruana de Radiologia
Secretary, Dr. Julio Bedoya Paredes, Apartado 2306, Lima, Peru. Meets monthly except during January, February and March, at Asociación Médica Peruana "Daniel A. Carrión," Villalta, 218, Lima.

Sociedad de Radiologica, Cancerologia y Fisica Medica del Uruguay
Secretary, Dr. Arias Bellini, Av. Agraciada 1464, Piso 13, Montevideo, Uruguay.

Continental Europe

Société Belge de Radiologie
General Secretary, Dr. S. Masy, 111 Avenue des Allies, Louvain, Belgium. Meets monthly, second Sunday at Maison des Médecins, Brussels.

Société Française d'Electro-Radiologie Médicale, and its branches: Société du Sud-Ouest, du Littoral Méditerranéen, du Centre et du Lyonnais, de l'Ouest, de l'Est, et d'Alger et d'Afrique du Nord
Secretary-General, Dr. A. Dariaux, 9 bis, Boulevard Rochechouart, Paris IX°, France.

Ceskoslovensk společnost pro rëntgenologii a Radiologii v Praze
Secretary, Dr. Roman Bláha, Praha XII, stát. nemocnice, Czechoslovakia. Meets monthly except during July, August, and September. Annual general meeting.

Deutsche Röntgen-Gesellschaft
Secretary, Dr. med. Peter Kröker, Evangelisches Krankenhaus, Huyssens Stiftung, (22a) Essen. Annual meeting, Sept. 5–8, 1954, Wiesbaden, Germany.

Societa Italiana di Radiologia Medica
Secretary, Prof. Mario Ponzio, Ospedale Mauriziano. Torino, Italy. Meets biannually.

Nederlandse Vereniging voor Electrologie en Roentgenologie
Secretary, Dr. B. J. Rethmeier, Bornsestraat 378, Almelo, Netherlands.

Polish Society of Radiology
Secretary, Dr. L. Zgliczynski, 59 Nowogrodzka St., Warsaw, Poland.

Gdansk Section, Polish Society of Radiology
Secretary, Dr. A. Smigielska, Akademia Lekarska, Gdansk. Meets monthly last Sunday at 10:30, X-Ray Dept.. Akademia Gdansk.

Wrocław Section, Polish Society of Radiology
Secretary, Dr. R. Marciniak, Akad. Medyczna Wrocław, 68 Curie-Skłodowska St., Wrocław, Poland. Meets first Sunday of each month, X-Ray Department, Akademia Medyczna Wrocław.

Societatea Romana de Radiologie si Electrologie
Secretary, Dr. Oscar Meller, Str. Banual Mărăcine, 30, S. I., Bucuresti, Roumania. Meets second Monday in every month with the exception of July and August.

All-Russian Roentgen Ray Association, Leningrad
USSR in the State Institute of Roentgenology and Radiology, 6 Roentgen St.
Secretaries, Drs. S. A. Reinberg and S. G. Simonson. Meets annually.

Scandinavian Roentgen Societies
The Scandinavian roentgen societies have formed a joint association called the Northern Association for Medical Radiology, meeting every second year in the different countries belonging to the Association.

Sociedad Espanola de Radiologia y Electrologia
Secretary, Dr. J. Martin-Crespo, Fuencarral, 7. Madrid, Spain. Meets monthly in Madrid.

Schweizerische Röntgen-Gesellschaft (Société Suisse de Radiologie)
Secretary, Dr. Max Hopf, Effingerstrasse 47, Bern, Switzerland.

India

Indian Radiological Association
Secretary, Dr. R. F. Sethna, Navsaii Building, Hornby Road, Bombay 1, India.

THE SCIENTIFIC EXHIBIT

The Scientific Exhibit at the Fifty-fifth Annual Meeting of the American Roentgen Ray Society held at the Shoreham Hotel, Washington, D. C., September 21 to 24, 1954, was arranged by the Committee on Scientific Exhibits under the chairmanship of Dr. Edward B. D. Neuhauser. This exhibit was undoubtedly the largest one in the Society's history and of the most excellent quality. The Committee on Awards had the greatest difficulty in selecting those meriting special recognition and after lengthy and thoughtful consideration awarded twelve prizes, among them the Gold Medal which was given for the first time in several years.

Following are brief descriptions of the exhibits, together with the awards which were made.

I. GOLD MEDAL. *Hypophosphatasia.* Edward B. D. Neuhauser, M.D., and Guido Currarino, M.D., Children's Medical Center, Boston, Massachusetts. An unusual refractory skeletal disorder characterized by defective bone formation was presented and illustrated. It may involve a few or all areas of enchondral or membranous bone formation, while the non-osseous growth processes continue. Clinically, histologically and roentgenologically these changes closely resemble rickets but peculiarly are accompanied by an abnormally low alkaline phosphatase activity of the serum and, in the patients who were studied, of the bones and other tissues as well. Serum calcium and phosphorus levels are normal and there is frequently, if not constantly, premature loss of deciduous teeth. The serology was negative and the diet and vitamin intake adequate. Siblings may be affected or show low alkaline phosphatase without roentgenologically demonstrating abnormality of bone. The parents who were studied showed no osseous lesions, but an abnormally low level of serum phosphatase was found in one or both of those in whom it was measured.

In this group of patients there were several severely affected infants who presented a soft, somewhat large skull with prominent scalp veins and wide and tense sutures and fontanelles without hydrocephalus, irritability, moderate anemia, poor appetite, failure to gain, muscular hypotonicity, normal sedimentation rate and unexplained fevers. A few patients slightly more advanced in age with a milder form of the disease were also included. Four infants with very severe abnormality of the skeleton who survived only briefly were included as probable examples of the extreme form of the condition, although the diagnosis is presumptive as no chemical determinations were made.

II. SILVER MEDAL. *Gamma-Ray Emitting Isotopes versus Radium.* Gilbert H. Fletcher, M.D., Warren K. Sinclair, Ph.D., and Fernando G. Bloedorn, M.D., The University of Texas, M. D. Anderson Hospital for Cancer Research, Houston, Texas. The advantages and disadvantages, and the fundamental dosimetry problems, in the use of the so-called radium substitutes, such as cobalt-60, cesium-137, gold-198, and tantalum-182 were demonstrated as follows: (1) *Cobalt-60, cesium-137 vs. radium:* 3-dimensional reconstructions of dosage patterns in implants according to the Paterson-Parker system for radium, Co^{60} and Ce^{137} needles. Photographs and essential components of equipment used for measurements at short distances, and color photographs of skin reactions of implants were shown. (2) *Tantalum-182:* A sample of tantalum wire, and roentgenograms of implants were shown. (3) *Au^{198} (Radioactive Gold):* (a) The Royal Cancer Hospital (London) technique; (b) the Ohio State University technique were illustrated.

III. BRONZE MEDAL. *Body Section Roentgenography; Fundamentals and Clinical Application.* Jacques de Moor, M.D., Philip J. Hodes, M.D., Richard H. Chamberlain, M.D., and Eugene P. Pendergrass, M.D., Department of Radiology, Hospital of the University of Pennsylvania, Philadelphia, Pennsylvania. Using the "Grossman principle" a series of experiments were planned to demonstrate the fundamentals of body section roentgenography. These were presented in the first half of the exhibit.

The second half of the exhibit concerned the clinical applications of body section roentgenography. In addition to routine body section studies, lesions were demonstrated which were sectioned using different techniques. Sharpness in the focal plane was emphasized; the importance of proper blurring was also illustrated.

CERTIFICATES OF MERIT

1. *Fibrous Dysplasia of the Skull, Facial Bones and Jaws.* John W. Fries, M.D., U. S. Naval Hospital, National Naval Medical Cen-

ter, Bethesda, Maryland. This exhibit consisted of 37 pathologically proved cases with roentgenograms demonstrating the area and degree of involvement of the osseous structures. All cases had clinical histories and some were supplemented with photographs. Lesions that can be recognized by roentgen examination are the following: (a) Pagetoid type—similar to Paget's disease. The skull is widened and the outer table is more noticeably affected with a "cotton wool" appearance. There is no evidence of osteoporosis circumscripta. (b) Sclerotic type—homogeneous density. There is a thickening of the involved skull or facial bone. (c) Cyst-like type—radiolucent; these usually occur singly, are 2–5 cm. in diameter and have a thin sclerotic border. Both tables of the skull are involved.

2. *Smooth Muscle Tumors of the Alimentary Tract: Roentgenologic Manifestations.* C. Allen Good, M.D., and Hillier L. Baker, Jr., M.D., Mayo Clinic, Rochester, Minnesota. Myomatous tumors comprise about 1 per cent of all neoplasms of the alimentary tract. This exhibit demonstrated the roentgenologic manifestations of these tumors as they involve the esophagus, stomach, small and large intestine. Morphologically these tumors may be classified as (a) intramural, 19 per cent; (b) submucosal, 47 per cent; (c) subserosal, 30 per cent; or (d) dumbbell, 4 per cent. Intramural tumors produce no roentgenologic manifestations. The characteristics of submucosal and subserosal tumors differ so that the two variations may be distinguished. Dumbbell tumors produce changes which combine the manifestations of both types.

3. *Intrasellar and Parasellar Lesions Demonstrated by Pneumoencephalography.* Joseph Hanelin, M.D., and Louis Bakay, M.D., Massachusetts General Hospital, Boston, Massachusetts. The detailed normal anatomy of the subarachnoid spaces about the sella turcica was reviewed and illustrated with roentgenograms of the living subject and cadaver. The normal air-filled chiasmatic and interpeduncular cisterns were shown in both lateral and anteroposterior projections. The anteroposterior projection has hitherto been neglected for the demonstration of these spaces primarily because they are obscured in the usual anteroposterior view by the ethmoid and sphenoid sinuses. If the central beam is directed caudad 30–35 degrees, satisfactory visualization of the parasellar cisterns can be accomplished. The paired sulci lying just anterior to the sella may also be shown in this projection. These paired air shadows may be displaced by intrasellar or parasellar lesions and their recognition is therefore of diagnostic importance.

Examples of pituitary adenoma, craniopharyngioma, meningioma, optic nerve glioma, and chordoma demonstrated by pneumoencephalography were shown. Many of these are outlined to good advantage in the anteroposterior as well as in the lateral projection. The degree of enlargement of the sella turcica cannot be used as an accurate guide to their size or to the amount of upward extension. They may also cause no visible enlargement or erosion of the sella.

Precise delineation of size and contour of these tumors, however, is afforded by air contrast. This information may be of considerable value to the neurosurgeon in planning an operative procedure. It also provides an objective method of following the course of these lesions which may have been irradiated, operated upon, or are being managed conservatively.

4. *Roentgen Abnormalities of the Large and Small Intestine Associated with Prolonged Cathartic Ingestion.* Norman Heilbrun, M.D., and Charles Bernstein, M.D., University of Buffalo School of Medicine, Buffalo, New York. In a series of patients, each of whom had ingested irritant cathartics daily for periods of fifteen to forty years, original film studies were presented revealing the stages of development and severity of the "enterocolitic"-like changes encountered in the large and small intestine. The significance of the absence of a clinical history of diarrhea, cramp-like or painful bowel movements and melena was emphasized, particularly in the differential diagnosis from ulcerative colitis and the so-called irritable colon. A theoretical basis for the roentgen findings and the relationships to the type of cathartics ingested were considered.

The type of cathartics used were: aloin, podophyllin, jalap, cascara, phenolphthalein, gamboge, calomel, and colocynth.

5. *Late Effects of Internally Deposited Radioactive Materials.* William B. Looney, M.D., and Martin Colodzin, B.S., U. S. Naval Hospital, National Naval Medical Center, Bethesda, Maryland. Four investigations of the late effects of internally deposited radioactive materials have recently been made. The investigation of the late effects of radium salts given

orally and intravenously to 50 patients for medical purposes and 28 patients employed as luminous dial workers was made at the Harvard Medical School, the Argonne National Laboratory and the Massachusetts Institute of Technology. The investigation of the late effects of thorotrast given to 250 patients was made at the Finsen Institute, Copenhagen, Denmark and the Naval Medical Center, in conjunction with the Universities of Utah and Rochester.

A summary of the clinical, histopathological, radioautographic, roentgenographic, and radiochemical findings was presented. Emphasis was placed on the clinical findings that may aid in the diagnosis of internally deposited radioactive materials. The importance of the data obtained from these patients for the more adequate protection of the increasing numbers of our population who will be exposed to radioactivity was stressed.

The following conclusions were reached:

(*A*) *Radium.*

1. Most of the radium is eliminated when taken into the body.

2. The retained radium is deposited irregularly in the skeleton in small areas of high radium concentration.

3. Roentgenographic changes characteristic of radioelement deposition develop many years after administration. Areas of decreased density occur in compact bone as a result of bone destruction. Areas of increased density occur in cancellous bone as a result of atypical osseous tissue formation.

4. There may be increased fragility of the skeleton following radium deposition. Fractures and aseptic necrosis occur with increased frequency.

5. Minor hematological changes may be present and infrequently aplastic anemias may develop. The sedimentation rate is usually elevated. Other laboratory examinations are usually noncontributory.

6. Skeletal malignancies may develop after radioelement deposition. Areas of decreased density on skeletal roentgenographic examination may be the first clinical evidence of malignancy.

(*B*) *Thorium.*

1. Almost all of the administered thorium from thorotrast is indefinitely retained.

2. Its primary sites of deposition are the liver, spleen, and bone marrow with lesser concentrations in lungs, adrenals, etc.

3. In general, there is comparatively little reaction and destruction. Exceptions to this, however, were in the spleen and those sites of injection where there was extravasion of thorotrast into the soft tissue.

4. The presence of thorotrast can be demonstrated roentgenographically in the liver, spleen and sites of extravasation in the neck and arms.

5. Slight thickening of the shafts and trabecular markings with irregularity of the endosteum have been demonstrated roentgenographically. Further work is in progress to determine if there is any relation between the roentgenographic changes and the administration of thorotrast.

6. Symptoms may develop from the marked contraction and induration at the sites of injection.

7. Minor hematological changes have been found in patients who received thorotrast and a small number of anemias have been reported. Some patients had abnormal liver function tests. The interpretation is difficult because of the underlying disease for which thorotrast was given.

8. No conclusions can be drawn concerning possible relation between thorotrast and the small number of malignancies in the liver and leukemias that have been thus far reported.

6. *Neonatal Lungs: Roentgen Appearance in Normal Infants and in Situations of Respiratory Distress.* H. G. Peterson, Jr., M. D., and M. E. Pendleton, M.D., Boston Lying-In Hospital, Boston, Massachusetts. Serial roentgenograms were shown to compare the progression of aeration and appearance of the lungs of: (1) Clinically normal newborn infants; (2) infants with the "hyaline membrane syndrome;" (3) infants with "aspiration syndrome" or respiratory distress secondary to aspiration of abnormal amniotic sac contents. Pertinent pathological material was also demonstrated.

7. *Broncholithiasis.* Coleman B. Rabin, M.D., Bernard S. Wolf, M.D., Sigmund A. Brahms, M.D., and Oscar H. Friedman, M.D., The Mount Sinai Hospital, New York, New York. This exhibit illustrated by colored diagrams, colored photographs of specimens, roentgenograms and laminagrams the nature, pathogenesis and roentgen appearance of broncholithiasis involving various segments of the lungs. The requisite for roentgen diagnosis in conventional chest roentgenograms, laminagrams and bronchograms was demonstrated. The material presented was selected from a group of proved cases. The location of stones in 65 cases was:

middle lobe, 29; anterior upper lobe, 16; all other segments, 11; main or other lobar bronchi, 9.

8. *Nonsurgical Cholangiography.* William H. Shehadi, M.D., New York Polyclinic Medical School and Hospital, New York, New York. Nonsurgical cholangiography is a procedure which will visualize the biliary tract without surgical intervention. This may be performed after oral administration of a cholecystographic medium, telepaque, visualizing the gallbladder as well as the extrahepatic ducts, especially the cystic and common bile ducts in normalcy.

Intravenously injected, cholografin is promptly excreted by the liver, resulting in visualization of the intrabiliary and extrabiliary radicles. This is of immeasurable value, especially in cholecystectomized patients. The bile ducts are demonstrated ten to twenty minutes after injection, with optimal visualization at thirty minutes. When present, the gallbladder is visualized in two to two and a half hours.

Cases illustrating normal and abnormal anatomy and physiology were presented, as well as a variety of pathological conditions demonstrated by the use of both telepaque and cholografin.

9. *The Internal Architecture of the Femur from the Orthopedic and Roentgenological Viewpoint.* William J. Tobin, M.D., and Marvin M. Gibson, M.D., Georgetown University School of Medicine, Smithsonian Institute; Armed Forces Institute of Pathology, Washington, D. C. The internal architecture of the femur was clearly demonstrated by transilluminated sections in various planes. The alterations from the normal in congenital, developmental and acquired deformities were shown, both by sections and roentgenograms. The clinical correlation of the internal structure of the femur to internal fixation of fractures of the neck of the femur, replacement prosthesis, osteotomies, etc., was included. The major trabecular patterns in the prenatal and postnatal femurs were shown. A section of the exhibit showed a comparative study of the internal structure of the femur from the roentgenological viewpoint.

The purpose of this exhibit was to demonstrate the internal architecture of the femur from the roentgenological and clinical viewpoints. The structurally weak area in the neck of the femur, Ward's triangle of the trigonum internum femoris, was shown. The femurs of various animals selected for their size, methods of locomotion and adaptation to nature were included for a comparative anatomical and roentgenological study.

Other Excellent Exhibits Were the Following:

Ulcerative Colitis: Roentgen Manifestations. Henry Woloshin, M.D., and John A. Kirkpatrick, M.D., Temple University Hospital, Philadelphia, Pennsylvania. The roentgen findings in early and late cases were illustrated. The value of follow-up studies was noted. The importance of deciding the extent of involvement was stressed and the signs of malignant changes were reviewed. It was concluded that although the rectosigmoid and left colon involvement is more common, the disease process may affect the right side of the colon and possibly the ileum. Roentgen examination is valuable in estimating the extent and the severity of the disease. An attempt should also be made to evaluate the terminal ileum as to involvement.

The Roentgen Appearance of the Pulmonary Veins in Heart Disease. Theodore E. Keats, M.D., Howard L. Steinbach, M.D., and Glenn E. Sheline, M.D., University of California School of Medicine, Department of Radiology, San Francisco, California. This exhibit demonstrated the anatomic and roentgen appearance of the pulmonary venous system and the variation in the size and caliber of these veins in heart disease. These variations have proved to be a useful clue in the differential diagnosis of the various types of congenital and acquired heart disease. This is particularly true when poststenotic dilatation is present in the pulmonary arteries associated with large proximal arteries. The size of the veins provides an additional indication of pulmonary flow. The exhibit showed small pulmonary veins in pulmonic valvular stenosis, tetralogy of Fallot and pulmonary artery thrombosis. Large veins occurred in cases of intracardiac shunts with left to right flow, patent ductus arteriosus and aortic pulmonary window. Of particular interest was the observation that the pulmonary veins were usually of normal size, although occasionally smaller or larger than normal, in mitral stenosis and in mitral stenosis plus mitral insufficiency, even though the right ventricle, pulmonary artery, and left atrium were definitely enlarged.

Melioidosis in Lung and Bone. Charles Oderr, M.D., Veterans Administration Hospital, New Orleans, Louisiana. This was the report of a case of a granuloma which remained of

undetermined etiology during five years of intensive study. The organism was finally recognized in a culture from a rib. Melioidosis should be considered in the differential diagnosis of suppurative lesions of the lungs, bones, and soft tissues when the etiology remains obscure, especially if the patient has been to the Eastern Continents of the world.

Benign Osteopetrosis. Arnold D. Piatt, M.D., Gerald A. Erhard, M.D., and Jacob S. Araj, M.D., Newark, Ohio. Osteopetrosis is a disease of bone usually found in infants and children with often a fatal termination, the so-called malignant form. Benign osteopetrosis may be mildly symptomatic or symptomless and can exist in youg individuals and adults. This type was described with the variations in the skeletal involvement. The differential diagnosis from other entities was mentioned. Nine cases were illustrated.

Intravenous Cholangiography: Demonstration of the Biliary Tract in Postcholecystectomy Patients. A. L. L. Bell, M.D., Lewis L. Immerman, M.D., and Joseph P. Arcomano, M.D., Long Island College Hospital, Brooklyn, New York. This exhibit was a demonstration of the biliary ducts in postcholecystectomy patients using intravenous cholografin alone and in conjunction with oral cholecystographic contrast medium in normal and abnormal states.

In the authors' practice combined intravenous cholangiography and laminagraphy has become a routine procedure.

Aortic Roentgenography. Curtis H. Burge, M.D., Frank M. Windrow, M.D., and Robert S. MacIntyre, M.D., Methodist Hospital Texas Medical Center, Houston, Texas. Roentgenograms demonstrating lesions of the aorta and its branches were shown and most of the lesions were demonstrated by color photographs made either at, or following, operation. In many cases photographs of the aortic homograft in situ following resection of the lesion were included. Brief case summaries were available on printed leaflets.

Regional Enteritis. Richard H. Marshak, M.D., Bernard S. Wolf, M.D., and B. B. Crohn, M.D., The Mount Sinai Hospital, New York, New York. Regional enteritis was originally described by Crohn, Ginzburg and Oppenheimer. Their description of the lesion was confined to the terminal ileum. Since that time numerous reports have appeared in the literature describing involvement of other segments of the intestinal tract. This exhibit demonstrated the various locations in the intestinal tract of this disease in a series of 750 cases: (1) terminal ileum, 448; (2) entire ileum, 180; (3) ileum and jejunum, 102; (4) jejunum, 12; (5) duodenum, 4; (6) stomach, 4; (7) colon (?).

The roentgen findings during the course of this disease and recurrences after side-tracking operations were shown. Comments on clinical and pathological findings were included.

Percutaneous Splenoportography Utilizing Rapid Serial Roentgenography. John A. Evans, M.D., and Ward D. O'Sullivan, M.D., The New York Hospital-Cornell Medical Center, New York, New York. In the surgical management of bleeding esophageal varices, anastomoses between the portal venous system and the caval venous system have proved to be a most satisfactory treatment. By such a veno-venous shunt the portal vein and its varicose tributaries in the esophagus are adequately decompressed.

Practically speaking, two types of anastomoses are available to the surgeon, the direct portocaval shunt and the splenorenal shunt. Knowledge of the patency and size of the portal and splenic veins before operation makes it possible for the surgeon to choose his type of shunt and so to plan intelligently his incision and exposure.

Percutaneous splenic portography provides an excellent means of visualizing the portal venous system before the patient is positioned on the operating table and the incision made. By this simple, safe technique, therefore, the possibility of many hours of fruitless search for a nonexistent or thrombosed vein is eliminated. The most suitable vein is chosen before the skin incision is made and it is directly and effectively approached.

The technique was illustrated with photographs, and in 6 cases the roentgenograms and diagrams of the findings were presented.

Orbital Pneumotography: Air Contrast Demonstration of Orbital Contents. William Dubilier, Jr., M.D., Alan S. Freemond, M.D., John M. McLean, M.D., and John A. Evans, M. D., New York Hospital-Cornell Medical Center, Departments of Radiology and Ophthalmology, New York, New York. Air is injected into the retrobulbar region to produce orbital emphysema. Laminagrams in the posteroanterior and lateral projections demonstrate the soft tissue structures of the orbit outlined by air. The globe, muscle bundles, and optic nerve are often well visualized. The method is useful for the delineation of orbital tumors. The technique was illustrated and in 2 cases laminagrams in

the posteroanterior and lateral views and colored photographs of the tumors removed were presented.

Left Auricular Enlargement in Congenital Heart Disease. Edward B. Singleton, M.D., and Dan G. McNamara, M.D., Texas Children's Hospital, Houston, Texas. The importance of the demonstration of left auricular enlargement in the diagnosis of acquired valvular heart disease is well known. Less attention has been given to the importance of enlargement of the left auricle in congenital malformations of the heart. Included in this exhibit were those cases of congenital heart disease commonly showing left auricular enlargement. Familiarity with this group of conditions enables the radiologist to differentiate more accurately between the types of congenital heart abnormality.

Roentgen Manifestations of Development of Primary Carcinoma of the Lung. Samuel Richman, M.D., Greensboro, North Carolina. For some time the author's attention has been attracted by roentgenograms of the chest on a number of patients with proved bronchogenic carcinoma of the lung, and whose condition had never previously been established even though roentgen examination of the chest had been done several times in the past. In some of these cases, there was a failure to observe the abnormality in the chest, and in others, the abnormal shadow was considered insignificant. This study has been made possible because, in most instances, previous roentgenograms taken elsewhere were available for comparison. Thus, the progress of the bronchogenic neoplasm could be followed from its "early" stage to the point when it attained considerable size. It may be added that with the exception of two photoroentgen films all of the examinations were made by using regular 14 by 17 inch size films.

Particular emphasis must be given to the fact that many lung infiltrations and nodules may be overlooked because of overlying bony structures or adjacent mediastinal tissues. To detect slight but significant changes, scrupulous comparisons should be made between roentgenograms taken at various intervals. It is in the asymptomatic carcinomas that previous chest films are so valuable for estimating the comparative size and appearance of the lung lesion.

Gas in the Portal Veins of the Liver in Infants: A Roentgenographic Demonstration with Postmortem Anatomical Correlation. John N. Wolfe, M.D., and William A. Evans, M.D., The Children's Hospital of Michigan, Detroit, Michigan. Antemortem roentgenograms were presented illustrating gas in the portal veins of the liver. Postmortem examinations have led to this conclusion.

The Value of the Right Lateral Decubitus (Kirklin's) Position in Oral Cholecystography. J. M. Dell, Jr., M.D., Gainesville, Florida. This exhibit consisted of films illustrating the value of this position in the following: (1) Obtaining gas-free shadows not obtainable by any other position. (2) In cases in which the gallbladder falls over the ileum. (3) In the demonstration of the hepatic and common ducts without the overlapping shadow of the gallbladder. There were also films illustrating the value of variations of the decubitus position, namely in both inspiration and expiration and with the patient a little backward or forward from the true lateral. Instances were presented showing the value of the fat meal film and the upright film.

The Diagnosis and Treatment of Congenital Anomalies of the Pulmonary Circulation. Israel Steinberg, M.D., and Nathaniel Finby, M.D., The New York Hospital-Cornell Medical Center, New York, New York. Conventional and angiocardiographic roentgenograms were used to illustrate the diagnosis and treatment of the following anomalies: (1) Absent main branch pulmonary artery, including lung agenesis; (2) patent ductus arteriosus with reversal of shunt; (3) aberrant insertions of pulmonary veins; (4) anomalous systemic arteries to lungs; (5) pulmonary arteriovenous fistulae; (6) primary dilatation (aneurysm) of the pulmonary artery; (7) pulmonic stenosis (valvular and infundibular).

Differentiation of Old and New Trauma of the Spine. Claude D. Baker, M.D., Frank E. Lane, R.T., and Everett L. Pirkey, M.D., University of Louisville School of Medicine, Louisville, Kentucky. A review and comparison of the photographic and geometric methods of enlargement of the roentgenographic image were given. The advantages of the use of the geometric method of enlargement with the ultrafine focus tube in the spine were stated. The ultrafine focus tube seems to aid in the differential diagnosis between old and new trauma of the spine. This technique should prove to be beneficial in medicolegal cases.

Small Bowel Examination in Intestinal Ascariasis. Captain John W. Beeler, M.C., U.S.A., United States Army Hospital, Fort Riley, Kansas. Barium examination of the small intestine is extremely valuable in the diagnosis of ascariasis. In this series of 64 patients the roentgen examination was diagnostic, even though repeated stool studies often were negative. This latter fact emphasizes the importance of examination of the small intestine in this condition. The majority of these patients served with the Armed Forces in Japan or Korea and a large percentage were repatriated prisoners of war.

A Modern Planning System for Roentgen Therapy of Deep-Seated Cancer. Bernard Roswit, M.D., Gustave Kaplan, M.D., and Elaine Rosen, B.A., Veterans Administration Hospital, Bronx, New York. The authors have developed a system of roentgen therapy for deep-seated cancer, utilizing the substantial advances of the past several years in radiation physics, dosage determination, radiobiology, tumor localization, precisional beam direction, and mold technology. This system is clinically practicable, widely applicable, and relatively inexpensive. The objective of this plan is to enhance the patient's chance for radiation cure by delivering a homogeneous lethal tumor dose with optimum precision, in an optimum time interval, with the least possible trauma to healthy intervening tissues.

Intravenous Cholangiography and Cholecystography. J. Gershon-Cohen, M.D., S. M. Berger, M.D., V. Kremens, M.D., H. Tumen, M.D., and E. M. Cohn, M.D., Albert Einstein Medical Center, Philadelphia, Pennsylvania. Reproductions of roentgenograms demonstrating the value of cholografin, a new contrast medium for rapid intravenous examination of the common duct and its tributaries and of the gallbladder were shown. Postcholecystectomy syndrome due to retained common duct stone can be studied with this new medium.

Osteopetrosis in Adults. C. L. Hinkel, M.D., D. D. Beiler, M.D., and T. R. Wilson, M.D., George F. Geisinger Memorial Hospital and Foss Clinic, Danville, Pennsylvania. The roentgenological characteristics of osteopetrosis in adults were illustrated by the presentation of the findings in four siblings over fifty years of age who have the disease. The familial characteristics, distributional pattern, differential diagnosis, and histological appearance were emphasized. The authors believe their patients have recovered from the active form of the disease.

The following characteristics of osteopetrosis in adults were listed:

1. Generalized symmetrical involvement. Some bones may be spared.
2. Bones commonly involved: pelvis, spine, proximal humerus, both ends of the femur.
3. "Bone within a bone appearance" (pelvis, vertebrae and small bones).
4. Longitudinal striations in metaphyses.
5. "Sandwich" vertebrae.
6. Onset in utero or in childhood.
7. Familial occurrence, especially in siblings.
8. Anemia usually absent.
9. Blood chemistry normal.
10. Predilection to fracture.
11. Remissions, periodic or permanent.
12. Benign clinical course.

An Economical Scintiscanner. Samuel V. Geyer, M.D., Theodore E. Sopp, B.S. (E.E.) and J. Stauffer Lehman, M.D., Hahneman Medical College and Hospital, Philadelphia, Pennsylvania. This exhibit illustrated an economical scintiscanner consisting of a roentgenographic table with two tube stands. One tube stand suspends a shielded Geiger tube for uptake studies, the other tube stand supports the scintiscanning device. Scintigrams of typical lesions were included.

National Survey of Congenital Malformations Resulting from Exposure to Roentgen Radiation. Stanley H. Macht, M.D., and Philip S. Lawrence, D.Sc., Washington County Hospital, Hagerstown, Maryland. The objective of the study was to determine whether males who have prolonged exposure to small doses of ionizing radiation differ from an unexposed group in fertility, in reproductive wastage, and in prevalence of congenital defects among the offspring. The effects of ionizing radiation on the prevalence of congenital anomalies among offspring of radiologists were compared with the prevalence among offspring of medical specialists not engaged in radiological work.

The data were obtained from questionnaires mailed to 3,658 radiologists and 3,587 other medical specialists whose names were taken from lists supplied by professional societies.

Statistical analysis of the returned schedules has been completed. The basic results have been tabulated with regard to family size, parity and age of mother. From additional data on the schedules, studies have been made of fertility,

sex ratios, and of the survey method employed.

Routine Operative Cholangiography. Maurice D. Sachs, M.D., and Philip F. Partington, M.D., Veterans Administration Hospital, Cleveland, Ohio.

Operative cholangiography is a useful diagnostic adjunct to the surgeon. The advantages of operative cholangiography are: (a) possibility of immediate anatomical orientation, especially in secondary operations; (b) detection of calculus and noncalculus obstruction of the common duct, a risk appreciably lower than the standard surgical exploration; (c) diagnosis of neoplastic and non-neoplastic diseases of the pancreas. The technique and conduct of operative cholangiography were illustrated in detail. This included a description of various cholangiographic media and of the roentgenologic equipment needed to satisfactorily perform the examination.

Patterns of Lobar Collapse: A Demonstration by Plexiglas Models with Roentgenographic Correlation. George R. Krause, M.D., and Mortimer Lubert, M.D., Mount Sinai Hospital, Cleveland, Ohio. The purpose of this exhibit was to illustrate the anatomical changes which are responsible for the roentgenographic appearance of a collapsing lobe. The models are intended as a teaching aid to explain and clarify the sequence of anatomical changes.

The exhibit consisted of approximately 12 life size plexiglas models, together with corresponding roentgenograms. The direction and pattern of collapse and the changes in shape which occur were demonstrated. The collapsing lobe was shown in translucent plexiglas; the normal or emphysematous lobe, in transparent plexiglas. Thus, one can look "through" the model in the same sense as one sees "through" the chest with roentgen rays. Comparison of the three-dimensional model with the roentgenogram explained the underlying anatomical structural changes. The difference between the appearance of the right and left upper lobes during collapse was clearly illustrated.

Asymmetry of the Osteophyte Formation in the Thoracic Spine. The Aorta Has a Preventive Effect on Osteophyte Formation. Gordon J. Culver, M.D., and Herbert S. Pirson, M.D., The Buffalo General Hospital, University of Buffalo School of Medicine, Buffalo, New York. This exhibit was designed to point out the asymmetry of osteophyte formation laterally in the thoracic spine. This finding has been present on a multitude of roentgenograms and anatomical sections; however, the exhibitors could find nothing in the available literature calling attention to this variation. The relationship of the aorta to the spine is the obvious etiologic factor. It would seem that aortic pulsations have a definite preventive effect on osteophyte formation.

Anatomic sections and representative roentgenograms in the exhibit confirmed the above observations.

Focal Pulmonary Hemosiderosis in Rheumatic Heart Disease. Michael J. Esposito, M.D., and John A. Evans, M.D., New York Hospital-Cornell Medical Center, New York, New York. This exhibit consisted of a series of roentgenograms depicting lung findings in cases of hemosiderosis, plus kodachrome slides demonstrating the pathological material in some of the cases. Study of 100 necropsied cases revealed 28 histological examples. The roentgenographic incidence was 5 per cent. A total of 8 cases with roentgen findings (7 autopsied) were presented. All had severe mitral stenosis. Aggregates of hemosiderin 1 to 3 mm. in diameter were responsible for the diffuse granular pulmonary nodulation.

The X-Ray Department at Work. The American Society of X-Ray Technicians, Fond du Lac, Wisconsin. This was an exhibit of seventeen salon mounted photographs of activities typical of an x-ray department. Literature published by the American Registry of X-Ray Technicians and The American Society of X-Ray Technicians was available for distribution. Copies of all Refresher Course books published by The American Society of X-Ray Technicians were also on display.

Bronchography with a New Rapidly Absorbed Contrast Material—Dionosil. Herbert M. Stauffer, M.D., and Charles M. Norris, M.D., Temple University Hospital, Departments of Radiology and Broncho-Esophagology, Philadelphia, Pennsylvania. This exhibit presented, with illustrations, the technique and results in more than 100 studies with a new bronchographic medium, "Dionosil" (trade name). This medium consists of the relatively insoluble propyl ester of iodine (related to diodrast) suspended either in aqueous solution of carboxymethyl cellulose or in peanut oil.

Excellent bronchographic contrast is obtained and the material is no more irritating than iodized poppy-seed oil, requiring similar preliminary anesthetization. In the lung, the radiopaque compound is absorbed after hydrolysis and is subsequently excreted in the urine. There is usually no roentgen evidence of residual

opaque material after twenty-four to forty-eight hours with the aqueous suspension and after four days with the oily medium. Systemic reactions have been rare and minimal.

THE COMMERCIAL EXHIBIT

The Commercial Exhibit at the Fifty-fifth Annual Meeting of the American Roentgen Ray Society held at the Shoreham Hotel, Washington, D. C., September 21 to 24, 1954, excelled all other commercial exhibits in the history of the Society in size and attractiveness of display. The unusual interest it created among the members of the Society and guests will no doubt long be remembered. The placing of all the papers of the scientific program in the morning afforded ample time for those attending the meeting to visit the individual exhibits at their leisure. This, together with the fact that the Exhibit Sections were in close proximity to the other activities of the Society proved a most fortunate arrangement. All of the exhibits were excellent and the Society extends its thanks and appreciation to the exhibiting firms for their part in contributing to the success of this meeting in such a notable manner.

The following are the firms who participated in the Commercial Exhibit:

Ansco, Binghamton, New York; *Automatic Seriograph Corporation*, College Park, Maryland; *Balteau Electric Corporation*, Stamford, Connecticut; *Barnes-Hind Barium Products Company*, San Francisco, California; *Bar-Ray Products Inc.*, Brooklyn, New York; *Bell-Craig, Inc.*, New York, New York; *Buck X-Ograph Company*, St. Louis, Missouri; *Dunlee Corporation*, Chicago, Illinois; *E. I. du Pont de Nemours & Co., Inc.*, Wilmington, Delaware; *Eastman Kodak Company*, Rochester, New York; *Eureka X-Ray Tube Corporation*, Chicago, Illinois; *Fairchild Camera & Instrument Corporation*, Jamaica, New York; *L. M. Forsyth Mfg. Company, Inc.*, Chicago, Illinois; *E. Fougera & Company, Inc.*, New York, New York; *F-R Machine Works*, Long Island City, New York; *Franklin X-Ray Corporation*, Philadelphia, Pennsylvania; *General Electric Company*, Milwaukee, Wisconsin; *Grune & Stratton, Inc.*, New York, New York; *Halsey X-Ray Products, Inc.*, Brooklyn, New York; *High Voltage Engineering Corporation*, Cambridge, Massachusetts; *Paul B. Hoeber, Inc.*, New York, New York; *Howdon Videx, Inc.*, New York, New York; *Isotope Accessories Company*, Philadelphia, Pennsylvania; *Keleket X-ray Corporation*, Covington, Kentucky; *Lea & Febiger*, Philadelphia, Pennsylvania; *Liebel-Flarsheim Company*, Cincinnati, Ohio; *Machlett Laboratories, Inc.*, Springdale, Connecticut; *Mallinckrodt Chemical Works*, St. Louis, Missouri; *F. Mattern Manufacturing Company*, Chicago, Illinois; *Micro X-Ray Recorder, Inc.*, Chicago, Illinois; *North American Philips Company, Inc.*, Mt. Vernon, New York; *Old Delft Optical Company, Inc.*, New York, New York; *Ortho Pharmaceutical Corporation*, Raritan, New Jersey; *Pako Corporation*, Minneapolis, Minnesota; *Picker X-Ray Corporation*, White Plains, New York: *Professional Equipment Company*, Maywood, Illinois; *Schering Corporation*, Bloomfield, New Jersey; *Frank Scholz X-Ray Corporation*, Boston, Massachusetts; *Standard X-Ray Company*, Chicago, Illinois; *Charles C Thomas, Publisher*, Springfield, Illinois; *Times Facsimile Corporation*, New York, New York; *Twin Viewer Company*, Chicago, Illinois; *United States Radium Corporation*, New York, New York; *Victoreen Instrument Company*, Cleveland, Ohio; *Westinghouse Electric Corporation*, Pittsburgh, Pennsylvania; *Wilmot Castle Company*, Rochester, New York; *Winthrop-Stearns Inc.*, New York, New York; *Year Book Publishers, Inc.*, Chicago, Illinois.

NEW OFFICERS OF THE AMERICAN ROENTGEN RAY SOCIETY

At the Fifty-fifth Annual Meeting of the American Roentgen Ray Society held at the Shoreham Hotel, Washington, D. C., September 21–24, 1954, the following officers were elected for the year 1954–1955: *President-Elect:* Dr. Paul C. Hodges, Chicago, Illinois; *1st Vice-President:* Dr. Frederic E. Templeton, Seattle, Washington; *2nd Vice-President:* Dr. James M. Dell, Jr., Gainesville, Florida; *Secretary:* Dr. Barton R. Young, Philadelphia, Pennsylvania (re-elected); *Treasurer:* Dr. Wendell G. Scott, St. Louis, Missouri (re-elected); *Member of the Executive Council:* Dr. E. B. D. Neuhauser, Boston, Massachusetts. The *President* is Dr. Joshua C. Dickinson, Tampa, Florida, and the *Chairman of the Executive Council* is Dr. W. Edward Chamberlain, Philadelphia, Pennsylvania.

RADIOLOGICAL SOCIETY OF KANSAS

The Radiological Society of Kansas and the Radiological Society of Greater Kansas City will hold a joint meeting in Kansas City, Kansas on February 14, 15, 16, and 17, 1955. The guest speakers are as follows: Dr. James W. Carpender, Chicago; Dr. L. V. Ackerman,

St. Louis; Mr. James Stober, technical director of the Kelley Koett Company; Dr. Philip J. Hodes, Philadelphia; Dr. William H. Beirwalles, Ann Arbor; Dr. Carl L. Gillies, Iowa City; Dr. John F. Holt, Ann Arbor; Dr. Carl C. Birkelo, Herman Keifer Hospital, Detroit; Dr. B. V. A. Low-Beer, University of California. Further information in regard to the program can be obtained from Dr. G. M. Tice, University of Kansas City Medical Center, Kansas City 3, Kansas.

COLORADO RADIOLOGICAL SOCIETY

The following new officers were elected at the meeting of the Colorado Radiological Society, held on September 17, 1954, in Denver, Colorado: *President*, Dr. R. Parker Allen, Denver, Colorado; *Vice President*, Dr. John H. Freed, Denver, Colorado; *Secretary*, Dr. Stuart A. Patterson, Larimer County Hospital, Fort Collins, Colorado; *Treasurer*, Dr. Thomas J. Kennedy, Denver, Colorado.

RADIOLOGICAL SOCIETY OF GREATER CINCINNATI

The following officers for the Radiological Society of Greater Cincinnati have been elected for the year 1954–1955: *President*, Dr. Chapin Hawley; *Vice President*, Dr. Emanuel Levin; *Secretary-Treasurer*, Dr. Wm. R. Dickens, Cincinnati General Hospital, Cincinnati 29, Ohio.

Vol. 72, No. 5

ABSTRACTS OF RADIOLOGICAL LITERATURE

Department Editor: T. Leucutia, M.D., Harper Hospital, Detroit 1, Michigan

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ROENTGEN DIAGNOSIS

Head

Pape, R., and Zakovsky, J. Die Röntgenstrahlensensibilität der Retina. (Radiosensitivity of the retina.) *Fortschr. a. d. Geb. d. Röntgenstrahlen ver. m. Röntgenpraxis*, Jan., 1954, *80*, 65–71.

Electroretinographic studies show that there is a parallel between the sensitivity of the retina to roentgen or gamma rays and ordinary light. In monocular tests, the light threshold is 1.6–8.7 mr.s. and is independent of the wave lengths ranging from 40–170 kv. The threshold is higher in older persons and varies in the same individual from time to time. Metallic objects held before the eye become distinguishable after a dark-adaptation period of thirty minutes, employing 71 kv. and 2 ma. A cloudy cornea or lens apparently does not affect retinal sensitivity to roentgen rays. Experiments indicate that the effect is directly on photoreceptors without detectable fluorescence, although an intraretinal, microscopic fluorescence is not excluded. The peripheral visual field is more sensitive than the central. These studies also corroborate the Bunsen-Roscoe law, that the time-intensity quotient is a constant.

Functional changes in the retinal apparatus occur at levels far below destructive doses. The authors plan to investigate the therapeutic applications of this fact.—Joseph Zausner, M.D.

Storni, Mario P. Collados, Ruggeri, Federico, Lavise, Jorge, and Villani, E. M. Angiografía carotidea en el estudio de la circulación cerebral por hipotensión arterial gobernada; communicación previa. (Carotid angiography with controlled hypotension in the study of cerebral circulation; preliminary report.) *Prensa méd. argent.*, Jan. 8, 1954, *41*, 115–119.

The hypotensive effect of the halogenous derivatives of methyl-ammonium polymethyl series is well known to anesthesiologists, who have used it to reduce bleeding in cranial surgery. The authors have tried it in carotid angiography.

Technique: After the needle has been introduced into the carotid artery the patient is anesthetized with sodium pentothal and placed in the Trendelenburg position, while oxygen is given through a nasal catheter. The blood pressure is taken and hexamethonium chloride is slowly injected intravenously in amounts of 0.5 to 1 mg. per kg. of body weight. When the systolic blood pressure is reduced to 60 or 70 mm. of mercury, a slight mydriasis occurs. At this point the contrast medium (10 cc. of 35 per cent nosylan R) is injected and two lateral and one anteroposterior roentgenogram are rapidly made.

Three patients have been studied taking roentgenograms with and without hexamethonium chloride; a better contrast was obtained when using it. A slowing down of the blood circulation and a reduction of the cerebral edema, resulting in a distention of the blood vessels, are apparently responsible for the better result—F. Comas, M.D.

Perese, Dogan M., Kite, William C., Bedell, Arthur J., and Campbell, Eldridge. Complications following cerebral angiography. *A.M.A. Arch. Neurol. & Phychiat.*, Jan., 1954, *71*, 105–115.

A series of 234 consecutive angiographic studies, using 35 per cent iodopyracet (diodrast), is reported.

There were 37 complications. One death, which occurred in a seven year old boy, is stated to be definitely due to the injection of iodopyracet. Six injections of 10 cc. each were made within forty minutes. Within five minutes after the last injection, respiration suddenly ceased. Autopsy revealed marked edema of the brain and congestion of the blood vessels therein. The authors state that their practice of limiting the total injection volume to 30 cc. or, at the most, 40 cc. in one carotid was violated. Fatalities were "seemingly" hastened by arteriography in 6 patients who entered the hospital in terminal stages of their illnesses. Three permanent hemiplegias occurred which appeared to have resulted from the procedure, 19 transient hemiplegias developed and contralateral sensory changes of a transient nature were noted in 6 instances. There was one instance of partial occlusion of the retinal artery.

Quotations from the literature give "clot embolus" as a frequent cause of hemiplegia. Aneurysm rupture from increased intravascular pressure following the injection, direct toxic action on nerve cells and vasospasm due to the iodopyracet are listed.

The authors conclude that cerebral angiography carries a definite hazard and that development of a safer substance than iodopyracet is urgently needed. —C. N. Borman, M.D.

Greenwald, Charles M., and Whitsett, Charles C. Roentgenographic diagnosis of acoustic nerve tumor. *Cleveland Clin. Quart.*, Jan., 1954, *21*, 40–45.

The diagnosis of acoustic nerve tumor is based primarily on the clinical examination; the roentgenographic study serves as a secondary aid. The lesion constitutes about 9 per cent of all brain tumors.

The tumor is attached to the 8th nerve, lies in the angle between the cerebellum and brain stem and the direction of growth is variable so that a large tumor may be present without involving the petrous apex or acoustic meatus. On the contrary, a tumor weighing only a few grams may have most of its mass in the meatus and cause marked erosion. Either the cochlear or vestibular branch may be the site of origin. Two basic histologic types are described: (1)

neurinomas, with the nerve fibers confined to the capsule and (2) neurofibromas, constituting a small percentage, having nerve fibrils throughout the tumor, reportedly occurring with von Recklinghausen's disease, tending to be bilateral, familial and, at times associated with meningiomas.

In a considerable proportion no definite changes are apparent on the roentgenographic study. In positive cases close scrutiny is required, since diminished density around the meatus with a sharp line of demarcation between involved and normal bone may be the only finding. Gross defects occur in only a minority of cases. The authors feel that about 50 per cent of cases will show sufficient changes to permit roentgen diagnosis.

Thirty-six of proved acoustic nerve tumors examined roentgenographically are reported; 75 per cent of cases were in women and the average age was forty-six years. Stereoscopic right lateral, posteroanterior and occipital (Towne) roentgenograms were obtained in all; 24 had additional roentgenograms in the basilar view and 22 in the Stenvers position.

The findings fell into two main categories: (1) local changes in the petrous bone in the region of the lesion, (2) nonspecific changes due to increased intracranial pressure.

In this series, there were 11 cases showing positive signs and 10 cases showing suggestive signs. Thus, in 58 per cent of cases the evidence was adequate to support the diagnosis (tentative diagnosis had been established previously in all cases).

By far the most valuable projection was Towne's view. Second in value was the basilar view. In no case was the Stenvers view most informative, and changes could be seen in only a small percentage of cases wherein it was utilized. Towne's view showed definite changes in all the positive cases and in 3 instances it was the only view to show erosion. In 8 of 10 cases showing suggestive findings, Towne's view provided the evidence. In 2 cases of the "suggestive" series of 10, the basilar view showed changes when Towne's view was negative. There were only 4 cases showing sellar changes indicative of increased intracranial pressure. Several instances of demineralization of the posterior clinoids were demonstrated but they fell within the range of normal variation.

The authors emphasize the point that roentgen changes depend largely on the direction of tumor growth. It is possible, but not probable, to have sellar changes from the tumor growth without definite localized changes in the petrous apex.—C. N. Borman, M.D.

Neck and Chest

Lahey, Frank H., and Warren, Kenneth W. Esophageal diverticula. *Surg., Gynec. & Obst.*, Jan., 1954, *98*, 1–28.

After a brief historical review, the authors discuss the physiology of swallowing and its relationship to the formation of pharyngoesophageal diverticula. When incoordination in the swallowing process occurs at the point of sphincter-like constriction of the cricopharyngei at the pharyngoesophageal junction, undue pressure is made upon this anatomically weak spot at the junction of the constrictors with the diverging fibers of the cricopharyngei (the pharyngeal dimple) and it is at this point that a false diverticulum occurs.

The authors distinguish three stages according to the degree of development. The first stage is merely a bulge of mucosa and submucosa without evidence of a true sac. In the second stage, there is formation of a globular sac and the opening of the diverticulum into the esophagus is laterally placed on the esophageal wall, but there is still a direct pathway into the esophagus. In the third stage, the true opening into the esophagus is a lateral slit, into which an esophagoscope or bougie cannot be manipulated. The mechanism of the production of esophageal obstruction in the third stage is based upon the fact that the large food filled diverticulum is dragged downward into the mediastinum until the pull of the sac converts the opening into the diverticulum itself from a lateral one into a transverse one, and the lips of the opening into the esophagus are approximated on the lateral wall by the downward traction of the sac making possible the passage of food into the esophagus only by spill-over from the diverticulum. The stages in the development of these diverticula are illustrated by diagrams and roentgenographic reproductions.

The authors emphasize that the diagnosis is made by means of a barium swallow. They state that roentgenograms should be taken in both anteroposterior, lateral or semilateral projections to rule out the possibility of an esophageal web. Another point in the roentgen diagnosis is that any irregularity in the outline of the barium-filled sac must suggest the possibility of a malignant lesion within the sac. Although this occurs but rarely, such a case is illustrated. The authors also warn of attempted esophagoscopy in third stage diverticula and illustrate such a case complicated by perforation and mediastinitis.

Much of the remainder of the article is devoted to a detailed description of the two stage operation as devised by the authors for dealing with pharyngoesophageal diverticula. They stress that they think it impossible to remove all the fibers of the cricopharyngeus with a one stage procedure. They dissect and free up the sac and stitch it superiorly to the sternohyoid muscle. Seven days later, aided by the edema that has occurred, they can reopen the wound and strip away the remaining fibers of the cricopharyngeus without difficulty. In an uncomplicated case the patient goes home in fourteen days. The mortality was 2 deaths in 365 operated cases and there were 12 recurrences in the 250 patients followed to the time of writing. This recurrence rate of 4.8 per cent included early cases in which the operative technique was not as refined.

The authors also present their experience with operations upon 9 patients with epiphrenic pulsion diverticula. The etiology and management of traction diverticula, largely conservative, is also included in the discussion.

The article is well illustrated and is indeed a comprehensive study, particularly of pharyngoesophageal diverticula and their management.—*William H. Smith, M.D.*

Sullivan, B. H., Jr., Geppert, Leo J., and Ranson, Robert F. Esophageal ulcer in very young infants. *A.M.A. Am. J. Dis. Child.*, Jan., 1954, *87*, 49–54.

A case is reported in this paper of fatal gastrointestinal hemorrhage from a small linear esophageal ulcer just above the gastric cardia of a newborn premature infant. Asphyxia and probably intracranial trauma were thought to have been important causal factors in the production of this ulceration.

Hemorrhage from the gastrointestinal tract in newborn infants is usually a lethal complication of "stress ulcer." Because of its frequent association with asphyxia, hemorrhage may call attention to previously undetected interference with respiration. Esophagitis, esophageal erosions and esophageal ulceration are but different degrees of severity of the same pathologic process. A definitive diagnosis of esophageal ulcer cannot be made without visualization of the lesion endoscopically or at surgery or autopsy. The lesions are seldom deep enough to be apparent on the roentgenogram, but functional spasm with outpouchings and constrictions of the lumen are regularly present and often are misinterpreted as ulcer craters. The demonstration of longitudinal striations above the level of the diaphragm is good evidence of herniation of a portion of the stomach into the thorax.

A case is also reported of reflux esophagitis in a four week old infant. Reflux esophagitis may occur in very young infants if a sliding type hiatus hernia is present. The mechanism is the same as in the adult. A complete obstruction of the esophagus occurred but relented three weeks after gastrostomy was performed. The obstruction was thought to have been the result of inflammatory edema and stricture. —*Ralph S. Bromer, M.D.*

Sweet, Richard H., Soutter, Lamar, and Valenzuela, Carlos Tejada. Muscle wall tumors of the esophagus. *J. Thoracic Surg.*, Jan., 1954, *27*, 13–35.

A series of 22 cases of muscle wall tumors of the esophagus is presented. Twenty were benign growths. Seventeen of the 20 benign tumors were leiomyomas, 2 were neurofibromas, and 1 was a myofibroma. Grossly, the benign tumors were well circumscribed and firm but not necessarily encapsulated. Multiple tumors were found in 4 of the 20 cases. These lesions were most frequent in the lower one-third of the esophagus.

Size was important in the production of symptoms. Most small benign tumors were asymptomatic; but lesions larger than 1-2 cm. in diameter which remained intramural usually produced symptoms. Pain, dysphagia and digestive symptoms such as eructation, nausea, postprandial pain were the common complaints.

A presumptive diagnosis may usually be made of benign muscle wall tumors of the esophagus by roentgen study. The lesion features a smooth indentation in the barium column with no break in the continuity of the mucous membrane pattern. Occasionally, lymph nodes, mediastinal structures and extramural neoplasms simulate intramural tumors of the esophagus. Esophagoscopy will usually help to make certain the tumor is not a carcinoma.

In the treatment of the benign muscle wall lesions, simple enucleation is advocated whenever possible. Sometimes, it is necessary to resect part of the esophagus to remove the tumor.

The two malignant tumors in the series were a leiomyosarcoma and a rhabdomyosarcoma. The diagnosis of these lesions requires a biopsy. Roentgenologically, they often appear as polypoid tumors. These primary sarcomas are rare and little is known about them. Surgical removal is advocated.—*Paul C. Olfelt, M.D.*

Boyer, Richard C., and Ramsay, Thomas R. Radiologic aspects of emphysema of the chest. *South. M. J.*, Jan., 1954, *47*, 10–17.

The authors point out that the word emphysema as related to the lungs, mediastinum and soft tissues of the thoracic wall is a descriptive term commonly used by a radiologist; however, the term is often employed rather loosely without due regard to the type of emphysema or its clinical importance. They further point out that the radiologist should have at his command a working classification of emphysema and attempt to place a given case in the proper category.

A classification of the various types of emphysema is presented which is not supposed to be a complete one since the acute forms of true pulmonary emphysema are omitted. Phases of soft tissue emphysema of the thoracic wall, divided into the type due to direct perforation of the chest wall and lung and the secondary type due to pulmonary interstitial emphysema, are first discussed. The mediastinal emphysema is divided into two types: that due to direct perforation of the tracheobronchial tree or esophagus and the type secondary to pulmonary interstitial emphysema. The pulmonary emphysema is divided into: (1) the non-obstructive type consisting of senile or postural emphysema and compensatory emphysema; and (2) the obstructive type which is subdivided into the localized obstructive type, bullous emphysema and the generalized type. Each of these are well discussed and illustrated.

The authors feel that emphysema of the chest should be studied both from the clinical and roentgenologic standpoints. The radiologist can do a service by urging the referring physician to evaluate the patient from the standpoint of dyspnea, cough and incapacity to work whenever generalized obstructive emphysema is suspected from the roentgen examination. They feel that proper application of numerous therapeutic measures, including the use of expectorants, bronchodilator drugs, postural drainage, breathing exercises, antibiotics, carefully controlled oxygen therapy and many other measures such as attention to the psychosomatic aspects of the disease, may all contribute to a more useful and much happier patient.—*Robert D. Moreton, M.D.*

Giuntoli, Lorenzo, and Chiappa, Sergio. Le manifestazioni stratigrafiche dell'enfisema nella silicosi polmonare. (Laminagraphic appearance of emphysema in pulmonary silicosis.) *Gior. ital. d. tuberc.*, Jan.-Feb., 1954, *8*, 1–10.

The authors believe that a generalized emphysema occurs early in the course of silicosis. On the other hand, the localized form of emphysema is usually the result of localized sclerosis of the lung with concomitant bronchial stenosis. Emphysematous bullae can thus be produced by the development of valvular action in the affected bronchi.

The authors are convinced that laminagraphy should be used routinely in cases of silicosis.—*Cesare Gianturco, M.D.*

Jones, W. A. Pulmonary histoplasmosis; a problem for the Armed Services and civil Departments of Health. *J. Canad. A. Radiologists*, Dec., 1953, *4*, 70–79.

The author describes 5 types of roentgen manifestations of pulmonary histoplasmosis: (1) virulent, (2) pneumonic, (3) disseminated, (4) nodular, and (5) solitary nodular type. In the majority of the cases the diagnosis is based on a positive histoplasmin skin test in the presence of a negative tuberculin skin test. Four illustrative case histories and roentgenograms are presented.—*James J. McCort, M.D.*

Boult, G. F. The radiological diagnosis of obstructive emphysema due to non-opaque foreign bodies. *J. Canad. A. Radiologists*, Dec., 1953, *4*, 80–83.

It is recommended that with a history of possible foreign body aspiration the radiologist should fluoroscope the patient first, then follow with inspiration and expiration roentgenograms and a single lateral roentgenogram. It is pointed out that the diagnosis of an aspirated foreign body may be missed if a single posteroanterior roentgenogram in inspiration is taken. Some vegetable foreign bodies may produce a violent pneumonitis. If fluoroscopic and roentgenographic examinations are negative and clinically there is a strong suspicion of foreign body aspiration, bronchoscopy should be done.—*James J. McCort, M.D.*

Malenchini, Manuel, Resano, J. Horacio, and Gugliatella, Helio. Contribución al estudio de las complicaciones respiratorias producidas por cuerpos extraños de esófago. (Contribution to the study of the respiratory complications produced by foreign bodies of the esophagus.) *Prensa méd. argent.*, *Dec.* 4, 1953, *40*, 3303–3308.

A report of a patient is cited who had ingested a bone while eating meat and forty-eight hours later had a right hydropneumothorax and left pleural effusion. This stimulated a review of the literature to find reports of complications due to foreign body in the esophagus.

These complications may be nervous, vascular and respiratory. An example of nervous complication is seen in the propagation of inflammation to the recurrent laryngeal nerve. Vascular complication is represented by perforation of the great vessels. Respiratory complications include asphyxia, mediastinitis, pleuritis and pneumothorax, esophagotracheal and esophagobronchial fistulas, pneumonitis and pulmonary gangrene. Atelectasis may be produced by inflammatory action on the phrenic nerve or bronchial compression. An asthmatic syndrome may be caused by foreign body in the esophagus, relief being obtained by removal of the foreign body.—*Charles Nice, M.D.*

Klinghoffer, June F. Löffler's syndrome following use of a vaginal cream. *Ann. Int. Med.*, Feb., 1954, *40*, 343–350.

The author presents the case history of a patient who developed fever, cough, and eosinophilia following vaginal instillation of AVC Improved, a preparation containing 9-aminoacridine sulfanilamide and allantoin with lactose in a water-miscible base. There was no history of previous allergy. Recovery occurred in three to four days with the use of antibiotics.

The patient was hospitalized with the fourth episode. Eosinophilia of 58 per cent and pulmonary infiltration were found. The lung findings as seen on roentgen examination were not migratory, however. Following recovery, test use of the vaginal cream resulted in the same clinical course of events with an eosinophilia of 46 per cent. The inability to demonstrate roentgen findings at this time were believed due to abbreviated exposure, since vaginal douching was begun promptly.

Scratch tests showed a positive skin reaction for the lactic acid component, but not for the allantoin or sulfonamide in the medication.—*Thomas B. Efford, M.D.*

Campbell, John A., Gastineau, David C., and Velios, Frank. Roentgen studies in suppurative pneumonia of infants and children. *J.A.M.A.*, Feb. 6, 1954, *154*, 468–472.

Acute suppurative pneumonia has long been a major pediatric problem. Although the over-all incidence is less than 10 per cent of all childhood pneumonias, a mortality even with modern antibiotics of 33 per cent for children and 40 per cent for infants has made it the major cause of death in lung inflammations.

Morphologically, it is an interstitial type of pneumonia with invasion of the bronchial walls, peribronchial tissues and interstitial structures as well as alveoli. Its alveolar consolidation decreases vital capacity and its interstitial character adds to this the suffocating effects of bronchial edema and parenchymal necrosis.

In the majority of cases the etiologic agent is *Micrococcus* (*Staphylococcus*) *aureus*. This is normally found in nose and throat cultures of over 85 per cent of all pediatric admissions. The organism, however, is apparently capable of becoming pathogenic when the infant's resistance is lowered by other diseases (virus infections, influenza, fibrocystic pancreatic disease, etc.). Less frequently streptococcus, Friedländer's bacillus, Proteus, pneumococcus or the tubercle bacillus may be responsible.

Invasion is chiefly by the bronchial route from the upper respiratory passages with extension to the pulmonary parenchyma via the lymphatics and interstitial tissues.

Since the causative agent occurs so frequently in normal nose and throat cultures, positive identification can be achieved only by culture from the lung or pleural cavity. For this reason roentgen examination becomes the simplest and most practical means of establishing a provisional diagnosis.

In an infant or younger child certain roentgen observations closely approach pathognomonic significance. The most consistent feature is the rapidly changing roentgen appearance, frequently in the presence of an unchanging clinical course. In the presence of overwhelming toxicity, the roentgen examination may show only mild emphysema; during convalescence the pulmonary and pleural invasions may be out of proportion to clinical manifestations.

The most reliable sign is the occurrence of a nontraumatic tension pneumothorax which in an infant is immediately suggestive of micrococcic pnuemonia. This is attributed to rupture into the pleural cavity of a subpleural abscess or pneumatocele in check-valve communication with a small bronchus.

Empyema develops by the same process. This may be either diffuse or encapsulated, depending on whether adhesive pleuritis has time to occur and localize the process. It is stated that 90 per cent of infants with empyema have micrococcic pneumonia.

Emphysema in either its segmental or diffuse form is common and is due to intramural bronchial edema producing obstruction. The diffuse type is most striking during the early stages and may obscure infiltrations in the lung causing a paradoxical clear chest roentgenogram in a dyspneic infant with severe clinical bronchopneumonia. Suppuration is present in these cases but toxemia may terminate the illness before pleural invasion occurs.

Pneumatoceles are a special form of emphysematous interstitial cavities. They are the result of penetration of a peribronchial abscess into a bronchus with the development of a cavity. A check-value mechanism at the outlet permits emphysematous inflation. The sudden appearance of such a cyst proved the presence of micrococcic pneumonia in an infant and makes the diagnosis probable in a young child.

Infiltrations of focal, segmental or lobar type in various combinations give rise to bizarre images, especially since different stages of involvement are seen simultaneously. The lobar densities are more frequently due to confluent atelectasis than pure consolidations. Acute abscesses are manifested as solid confluent densities following the course of the bronchi and blood vessels. Typical lung abscesses rarely occur.

An unequivocal diagnosis of suppurative bronchopneumonia probably is never justified on the roentgen evidence alone. Yet with the signs described above, the roentgen examination shows a sufficiently large specificity to provide early recognition of this entity.—*William C. MacCarty, Jr., M.D.*

Metras, H., and Charpin, J. Lung abscess and bronchial catheterization. I. Bronchography by catheterization in lung abscesses. *J. Thoracic Surg.*, Feb., 1954, *27*, 157–172.

The authors describe a method of bronchial catheterization for the diagnosis and treatment of lung abscesses. They were concerned only with abscesses due to no pre-existing lesion such as bronchial carcinoma, neighboring bronchiectasis, etc.

By means of mirror vision, a stiff radiopaque rubber catheter on a metal guiding mantrel is passed down into the larynx. Then the mantrel is removed and the catheter is passed farther down under fluoroscopic control. The end of the catheter is introduced into the lobe or involved segment by "small back and forth revolving motions." While in the classical form of bronchography, contrast medium seldom gets into the abscess cavity, the catheter in this procedure blocks up the draining bronchus and the injected medium, usually a water soluble contrast agent, nearly always penetrates the suppurative lesion. The catheter does not penetrate the lesion itself.

The authors feel the method is highly profitable since it gives an accurate anatomic picture of the lesions at the beginning of the treatment; and when done after completion of therapy, it contributes to

the correct appreciation of the final results. Instillations of antibiotics, usually a combination of penicillin, aureomycin and a sulfanomide, directly into the bronchus of the lesion by the same technique, are done every other day. Treatments ranged in number from 6 to 20. The results of this form of therapy in 51 primary lung abscesses indicated that 64 per cent of the cases were clinically healed for more than two years. About half of the clinically healed patients showed no anatomic residuals of the disease on final bronchography; 27.5 per cent did not respond satisfactorily to the treatment and in 8 per cent the time interval after therapy was not long enough for final evaluation.—*Paul C. Olfelt, M.D.*

Rogers, James V., and Leigh, Ted F. Differential diagnosis of right cardiophrenic angle masses. *Radiology*, Dec., 1953, *61*, 871–878.

For the roentgen differential diagnosis of masses in the right cardiophrenic angle, one or more of the following procedures are useful: (1) routine posteroanterior and right lateral roentgenograms for identification of the lesion; (2) fluoroscopy to determine the position of the mass in relation to adjacent structures, variation in size and shape with respiration, and the presence of transmitted or intrinsic pulsations, (3) laminagrams of the right cardiophrenic angle in frontal and lateral projections for better delineation of the mass and its relation to adjacent structures; (4) an abdominal roentgenogram or barium enema study for localization of the transverse colon; (5) upright chest roentgenograms following pneumoperitoneum; (6) upright and decubitus roentgenograms following pneumothorax, (7) occasionally an angiocardiogram or bronchogram.

The majority of right cardiophrenic angle masses are congenital pericardial celomic cysts and diverticula or omental herniations through the right foramen of Morgagni. The smaller pericardial cysts and diverticula are pliable and assume a "tear drop" appearance on the lateral roentgenogram as they project between the middle and lower lobes. Diagnosis of the larger cysts is dependent upon changes in size and shape.

Herniations through the right foramen of Morgagni usually consist of intestine in the younger age group and omentum in the older group. Roentgenologically, omental herniations are identified by the following features: (1) they cannot be separated from the diaphragm, (2) they may become smaller with expiration, (3) the transverse colon is frequently elevated and represents an inverted V or U shape, (4) following pneumoperitoneum, air usually enters the sac and can be identified on roentgenograms.

Other conditions producing a mass in the right cardiophrenic angle include pericardial fat pads, pleural reflections over the inferior vena cava, pleural thickenings, and segmental eventrations of the diaphragm. Other rare conditions which may enter into the differential diagnosis are mentioned.

Several case reports and illustrative roentgenograms of various described conditions are presented. It is concluded that the diagnosis of many right cardiophrenic angle masses can be established with reasonable certainty by roentgenologic procedures.—*Everett E. Seedorf, M.D.*

Hauch, H. J., and Hertz, C. W. Das arteriovenöse Lungenaneurysma. (Pulmonary arteriovenous aneurysm.) *Thoraxchirurgie*, Jan., 1954, *1*, 411–429.

Diagnosis of pulmonary arteriovenous aneurysm is of special interest because of curability by lobectomy. An outstanding early finding is cyanosis due to arteriovenous shunt in the lesser circulation which may be absent only in aneurysms of small size. Dyspnea on exertion develops later. Other findings are clubbing of the fingers due to low O_2 saturation of the arterial blood, late systolic murmur and diastolic machinery murmur, polyglobulia, polycythemia, increased blood volume and high hematocrit values.

Roentgenographically round, grapelike coalescent areas of increased density, connected with the hilus by bandform structures, are found. Pulsation is present except when hemorrhage occurs into surrounding tissues. With the Valsalva and Mueller tests the mass will get either smaller or larger. Angiocardiography reveals opacification of the mass and premature opacification of the left atrium and left ventricle. Resistance of circulation is diminished in the region of the aneurysm, but increased in the normal lung portions, which is believed to be a compensatory mechanism.

The authors report 2 cases. The first patient was a boy, aged fourteen, who had had cyanosis since the age of five, dyspnea on exertion for a year and slight clubbing of fingers. There was a systolic murmur over the cardiac base, 22.4 per cent hemoglobin and 7.9 million red blood cell count. Hematocrit was 63 per cent. Roentgenographically a pulsating grapelike mass was found in the right middle lung field. Selective angiocardiography with the tip of the catheter within the mass confirmed the impression of a pulmonary arteriovenous aneurysm. A lobectomy was performed and the patient was completely cured within a period of eight weeks.

The second patient was a boy, aged twelve, with cyanosis since birth and dyspnea on exertion for a year, also slight clubbing of fingers. Hemoglobin was 19 per cent, and the red blood cell count 6.3 million. Roentgen study was inconclusive since only increased pulmonary markings were found at the lower pole of the left hilus. Cardiac catheterization revealed a 50 per cent arteriovenous shunt, either extracardiac or intracardiac, and angiocardiography showed an area of opacification in the left lower lobe, mostly in the

retrocardiac space. Selective angiocardiography was not entirely conclusive and the impression of a pulmonary aneurysm had be to confirmed during operation with the aid of additional clinical tests. A lobectomy was performed and the patient was completely cured soon thereafter.—*Ernest Kraft, M.D.*

Linden, Irwin H., and Steffen, Charles G. Pulmonary cryptococcosis; introduction and review of the literature. *Am. Rev. Tuberc.*, Jan., 1954, *69*, 116–120.

A case of cryptococcosis localized to the lung, which developed in a patient shortly after discontinuation of long term therapy with cortisone for pemphigus vulgaris is reported. The disease extended over a ten week period and resolved spontaneously; it appeared to progress for one month, after which it underwent slow resolution during the succeeding six weeks.

The criteria of diagnosis were as follows: demonstration of the organism in the sputum on numerous occasions during the period of active disease; proof that the organism was pathogenic; disappearance of the organism concurrent with resolution of the pneumonic process; and failure to recover other known pathogenic bacteria or fungi.—*James F. McCort, M.D.*

Forsee, James H., and Blake, Hu A. Pulmonary cystic changes in xanthomatosis. *Ann. Surg.*, Jan., 1954, *139*, 76–83.

The disorder xanthomatosis is thought to be occasionally associated with pulmonary cystic changes. This presentation is concerned with the normocholesteremic type and emphasizes the pulmonary cystic changes which have been observed in 4 patients.

Widespread tissue involvement characterizes xanthomatosis. The skin, dura, orbit, pituitary gland, brain, liver, spleen, lymphatics, bone, tracheobronchial tree, lung and pleura have been reported involved.

The alterations in the lung seen in xanthomatosis are considered as being due to two factors: first, a granulomatous process involving the pulmonary interstitial tissues; second, bronchiolar obstruction.

Holm and his co-workers have described four histopathological phases encountered during the course of generalized xanthomatosis. First, there is histiocytic proliferation and local accumulation of eosinophils. Foam cells are not seen in this phase. Second, a granulomatous reaction develops characterized by the appearance of young blood vessels, reticular cells, histiocytes, eosinophils, giant cells and beginning lipoid phagocytosis. The third is an xanthomatous phase characterized by the appearance of isolated or groups of foam cells. The fourth phase is that of fibrosis and healing. These histopathological features overlap considerably just as the clinical characteristics merge.

The case histories of the 4 patients are presented. All showed varying pulmonary changes. In 1 case innumerable bilateral air and fluid filled cysts up to 3 cm. in diameter were noted. Bilateral nodular infiltrations, irregular stringy densities, or soft appearing infiltrations throughout both lungs were seen in the other cases.

The symptoms were chiefly cough, weight loss, fatigability, low grade fever. One patient had blood streaked sputum; 2 patients had lytic bone lesions; 1 patient had a 10 per cent peripheral eosinophilia.

Conclusions. The diagnosis of many intrathoracic lesions requires surgical exploration and histopathologic examination of the excised tissue, but even then in some cases may be equivocal. Differentiation of the proliferative and granulomatous phases of xanthomatosis from neoplasm may be difficult, as the characteristic xanthoma cells are seen only in the more mature lesions. Widespread tissue involvement and an undifferentiated microscopic appearance with only little deterioration of health suggest xanthomatosis. The cystic changes noted in the patients described are thought to be due to pulmonary interstitial involvement and branchiolar obstruction. Observations of these patients suggests that Hand-Schüller-Christian disease, Letterer-Siwe disease, lipoid granulomatosis and eosinophilic granuloma of bone and lung may be mere facets in primary normocholesteremic xanthomatosis.—*Robert K. Arbuckle, M.D.*

Steen, R. E. Team diagnosis of congenital heart disease. *Irish J. M. Sc.*, Jan., 1954, *6*, 1–16.

The author gives a brief preliminary historical analysis of the surgical treatment of congenital heart disease starting with ligating of a patent ductus by Gross in 1939. The work of Blalock and Taussig and of others is discussed briefly.

The etiological factor in many cases of congenital heart disease is felt by the author to be due to the virus of rubella and possibly to other viruses, such as found in the common cold, infectious hepatitis, etc.

The diagnosis of congenital heart disease is carried out in two stages:

1. The diagnosis of congenital from acquired heart disease and,

2. The diagnosis of the type of congenital heart disease.

In the first stage are considered: (1) the age of the patient; organic disease under 2½ years is considered congenital, (2) organic murmurs which are not rheumatic are considered congenital; (3) cyanosis, clubbing and polycythemia are in favor of congenital heart disease.

In the second stage of diagnosis the methods used are: (1) clinical; (2) roentgenological; (3) electrocardiographic, and (4) special techniques such as angiocardiography and cardiac catheterization.

The important clinical factor of cyanosis *vs.*

acyanosis is discussed. This is divided into the central type, *i.e.*, cyanosis affecting the warm surfaces, conjunctiva, lips, etc., and the peripheral type, which is due to stagnation of blood in the capillaries and can be due to many physiological and pathological conditions. Central cyanosis is significant in congenital heart disease but may not be evident until the arterial oxygen saturation has fallen to about 75 per cent (normal 94–97 per cent). In peripheral cyanosis arterial oxygen saturation is normal.

The important roentgenological factor is vascularity of the lungs. Increased vascularity occurs in arteriovenous shunts such as patent ductus, auricular septal defect, ventricular septal defect and Eisenmenger's complex. Decreased vascularity is noted in Fallot's tetralogy and in tricuspid atresia. Charts are given with characteristic roentgenologic findings.

Cardiac catheterization is discussed with a preliminary historical review beginning with Forssman's self catheterization of the heart in 1929. The mortality of this procedure is about 1:1,000 and less in capable hands. Thrombosis is the main complicating factor especially in the cyanotic group.

Purposes of cardiac catheterization are: (1) obtaining blood samples for oxygen analysis, and (2) pressure readings. The equipment includes American nylon catheters No. 6, 7, 8, and 9, with No. 7 and 8 catheters being the ones most commonly used. Pyrogen free sterilization should be done to prevent severe reactions. Manometer of the saline type, preferably electrically controlled, is used. Blood samples are taken under a paraffin seal and kept in ice and in the dark. Oxygen saturations are measured with the Haldane apparatus. The limit of fluoroscopy is set at fifteen minutes. No gloves need be worn during the fluoroscopy.

The author feels that the child should be prepared psychologically by having him in the hospital a few days prior to the examination. A small dose of quinidine is given to diminish the tendency for cardiac irregularities. Pencillin and heparin are also used—the heparin given at the beginning of the study and in the intravenous drip. Presedation may or may not be done. No general anesthetics are given as these would affect the oxygen saturation. The technique consists of threading the catheter through an antecubital vein, preferably the left side, and into the heart as desired. The finer points of the technique are discussed. The position of the catheter is controlled fluoroscopically.

Angiocariography is discussed by the author both as to its indications and value as well as technique. He feels that a high mortality exists, especially in the cyanotic group, and that the method, therefore, should be used only when necessary. The author used this technique only once in his hospital and that was on a mongoloid patient.

A brief description of the angiocardiographic technique is given with illustrations of roentgenograms and equipment. A multiple cassette changer is used, taking exposures of 1 per second but he feels that 2 per second would be better because of the rapidity with which the opaque medium passes through the heart.—*Leslie L. Lemak, M.D.*

Zinsser, Harry F., Jr., and Johnson, Julian. The use of angiocardiography in the selection of patients for mitral valvular surgery. *Ann. Int. Med.*, Dec., 1953, *39*, 1200–1218.

Angiocardiographic study of a total of 150 patients with mitral disease is reported from the Departments of Surgery and Radiology of the Hospital of the University of Pennsylvania. Initially, only patients with "pure" mitral stenosis were studied but later similar examinations were conducted on those thought clinically to have major mitral insufficiency.

The roentgenologic criteria for pure mitral stenosis were a sharply outlined dense left atrial shadow in the presence of delayed opacification of the entire left heart, marked cardiac enlargement and fibrillation. In the so-called "wide open" insufficiency, enlargement of the left atrium and particularly of the ventricle was pronounced without the difference in degree of opacification.

Employing these principles for selecting patients suitable for mitral commissurotomy, 123 operations were performed with an operative mortality of 14 per cent. Sixteen patients denied surgery by this study were all from the group felt clinically to represent predominant mitral regurgitation. Pure mitral stenosis diagnosed clinically was thus found to be a reliable conclusion and angiocardiographic studies were not felt necessary before surgery was undertaken.

Of all patients exhibiting loud apical systolic murmurs, 63 were found to have roentgen changes suggesting significant stenosis and, of these, 57 were found at operation to have anatomical mitral stenosis without significant regurgitation. The remaining 6 patients were thought to have adequate valve widths but 5 of these enjoyed symptomatic improvement as a result of further widening of the valves, thus suggesting the possible concept in these instances of a "functional stenosis." It is of interest to note that 5 instances of significant stenosis were detected in patients with loud apical systolic murmurs but no detectable diastolic murmurs.

Errors in roentgen diagnosis of stenosis were the result of clots in the left atrium preventing total demonstration of the chamber or were due to slow injection of the contrast substance. Occasional uncertainty in identifying a separate left ventricular shadow was the major cause of false negative diagnoses.—*James A. Martin, M.D.*

Gibson, Stanley, White, Harvey, Johnson, Frank, and Potts, W. J. Congenital pulmonary stenosis with intact ventricular septum. *A.M.A. Am. J. Dis. Child.*, Jan., 1954, *87*, 26–39.

Congenital pulmonary stenosis occurs most frequently in conjunction with defect of the ventricular septum, overriding of the aorta, and hypertrophy of the right ventricle. In this syndrome, known as the tetralogy of Fallot, the stenosis practically always involves the infundibulum of the right ventricle, and the pulmonary valve may be normal. In certain instances the stenosis is valvular, but here also the infundibulum shows more or less narrowing.

There is a second type of congenital pulmonary stenosis, less frequent, but by no means rare, in which the ventricular septum is intact. Obviously, there can be no overriding of the aorta. There may, however, be a right-to-left shunt through the foramen ovale if it has remained open or has been forced open by increased pressure on the right side of the heart. The pathology in the region of the pulmonary valve offers a sharp contrast to that seen in the tetralogy of Fallot. The infundibulum of the right ventricle is distended and shares in the high pressure which occurs in the main cavity of the ventricle. The stenosis of the valve is characterized by thickening and fusion of the cusp, so that it appears as a domelike structure protruding into the lumen of the pulmonary artery. The pulmonary artery immediately distal to the valve is dilated. In both of these forms, surgery has produced dramatic results.

The authors observed 45 patients believed to have pulmonary stenosis with intact ventricular septum. In 10 patients pulmonary valvulotomy was not done and in all of these the diagnosis was proved at autopsy. Thirty-five patients were subjected to pulmonary valvulotomy, and in one of these the diagnosis was confirmed at autopsy. The authors believe that the material which they present in this paper is unusual in that it concerns chiefly infants and young children.

The symptomatology is variable, depending upon the severity of the pulmonary stenosis and the presence and degree of shunting of blood from right to left through an open foramen ovale. In the severer cases, cyanosis may occur in early infancy together with attacks of paroxysmal dyspnea. In the milder cases, cyanosis may be minimal or absent, and little or no decrease in exercise tolerance may be noted.

The roentgenogram usually reveals cardiac enlargement involving the right auricle and the right ventricle. The pulmonary artery segment is prominent. The lung fields are abnormally clear. The electrocardiogram shows right heart strain with tall peaked P waves particularly noticeable in Lead II.

Pulmonary stenosis with intact ventricular septum must be differentiated from other types of pulmonary stenosis, namely, the tetralogy of Fallot, congenital tricuspid atresia, transposition of the great vessels with pulmonary stenosis, and Ebstein's anomaly of the tricuspid valve.

The surgical approach is briefly discussed in the paper and the spectacular improvement following surgery is pointed out. The authors note that some of their patients had been in extremis with marked cyanosis and severe dyspnea, whereas others were practically free of symptoms. They accordingly give an explanation of their choice of title for this paper. In severe pulmonary stenosis in which blood is unable to escape through an overriding aorta, the pressure in the right ventricle becomes very high, the tricuspid valve becomes insufficient, and pressure in the right auricle is increased. This may be sufficient to prevent closure of the foramen ovale or to force it open if it has already closed. A right-to-left shunt is thus established, and if a sufficient amount of blood flows through the foramen ovale, cyanosis results. The presence of cyanosis in the vast majority of their cases left no doubt that the foramen ovale was open. For these a proper title would have been "Congenital pulmonary stenosis with open foramen ovale." In those few, however, who were free from cyanosis there was little if any right-to-left shunt. The authors regard the question of whether the foramen ovale is open or closed as a minor consideration. The condition of the ventricular septum is all important. A shunt operation in a patient with a closed ventricular septum leads to his eventual death unless the mistake is discovered and corrective surgery instituted.—*Ralph S. Bromer, M.D.*

Krall, J. Die Blockade der Arteria pulmonalis als Grundlage einer präoperativen Funktionsprüfung in der Lungenchirurgie. (Blocking of the pulmonary artery as basis for a preoperative functional test in throacic surgery.) *Thoraxchirurgie*, Jan., 1954, *1*, 434–443.

Cardiac and pulmonary functional tests are important for the thoracic surgeon in regard to therapeutic indications and postoperative prognosis. When pneumonectomy is contemplated, the postoperative status can be imitated by preoperative blocking of the pulmonary artery.

For the procedure a cardiac catheter with two lumina is used. The opening at the tip is sealed off and a new opening is made 8 mm. away from the tip. A rubber bladder is now pulled over the tip and the new opening, and is sealed at both ends. A second opening is made 10 cm. from the tip of the catheter so that blood samples can be withdrawn and blood pressures in the heart and lung can be measured. When the cardiac catheter has been introduced, with its tip in the pulmonary artery of the diseased lung, the balloon is inflated with an aqueous contrast solution, the contrast being needed for fluoroscopic and roentgenographic controls.

After the pulmonary artery has been blocked, the O_2 tension is determined in the arterial blood of the femoral artery. Lowering of the O_2 tension following the block has been occasionally observed, being a contraindication for pneumonectomy.

Pressure studies revealed always an increase of the maximal 10 mm. Hg. value immediately following

the block. When the increase remains constant throughout a thirty minute testing period the right heart is believed to show increased work output and therefore impaired functional reserve.

Six roentgenographic reproductions illustrate the procedure and simultaneous pulmonary arteriography, either through a third lumen or through a separate catheter introduced into the contralateral cubital vein or a saphenous vein.

For details of technical and laboratory data a study of the original article is recommended.—*Ernest Kraft, M.D.*

Golper, Marvin N. Endocardial fibroelastosis; with a case presentation. *Radiology*, Dec., 1953, *61*, 865–870.

The author presents a case of this rather rare cardiac condition. He points out that it should be recognized by the radiologist, since it is one of the cardiac abnormalities causing cyanosis, but not being amenable to present day cardiovascular surgery.

Pathologically there is thickening and fibrosis of the endocardium of the left ventricle and, rarely, of the right ventricle. These are believed, by most observers to be developmental in origin. There is cardiac enlargement, due both to myocardial hypertrophy and dilatation. From a clinical standpoint, the disease occurs primarily in infancy and childhood. Physical findings are those of cardiac enlargement and heart failure and are not specific for this entity. Antemortem diagnosis is thought possible if abnormalities causing cardiac failure can be excluded on the basis of predominance of left ventricular enlargement rather than overall enlargement and the absence of typical electrocardiographic findings.

The prognosis is poor but some of the patients respond to treatment for cardiac failure. Repeated bouts of left ventricular failure are usually precipitated by respiratory infection.

In the case presented the antemortem diagnosis was "myocarditis;" endocardial fibroelastosis was found at necropsy.—*Michael J. Healy, M.D.*

Clagett, O. Theron, Kirklin, John W., and Edwards, Jesse E. Anatomic variations and pathologic changes in coarctation of the aorta; a study of 124 cases. *Surg., Gynec. & Obst.*, Jan., 1954, *98*, 103–114.

This study of 124 cases of coarctation of the aorta treated surgically emphasizes the anatomic variations and pathologic changes that may occur in the aorta and its branches at and near the site of stricture and the effects of these on operability.

The classification of coarctation should include:

(1) Relative position of the coarctation and the ductus arteriosus.

(2) The patency of the ductus arteriosus (charts show classification and causes of unequal blood pressure in upper extremities).

There were 42 females and 82 males in this series. The study indicates that the incidence of degenerative changes of the aorta and its branches manifested by intimal fibrotic and atherosclerotic changes in the proximal segment and the formation of aneurysms in the distal segment increases with the age of the patient; these changes are likely to be more severe in males than females, probably because of increased strain imposed on the cardiovascular system.

The nature of the coarctation is described by Edwards as showing a curtainlike infolding of the media demonstrated adequately by photographs of specimens and photomicrographs. No overgrowth of tissue of the ductus arteriosus into the aortic wall was observed. It is postulated that the curtain results from degrees of differential growth of the aorta in association with the developmental progress of the left subclavian artery.

It was not possible to anticipate the size of the lumen at the site of the stricture by examination of the exterior of the aorta. In most cases, an aortic lumen was present but rarely over 2 mm. in diameter. Great variation in the length of the aortic stricture was noted.

The importance of the relation of the left subclavian artery to the coarctation of the aorta is discussed.

Gross and histopathological changes in the aortic wall show changes proximal and distal to the coarctation due to physiological stress.

Associated anomalies of the cardiovascular system, particularly patent ductus arteriosus, occur frequently but do not necessarily contraindicate operation for coarctation.—*Ernest R. Seitz, M.D.*

Wolkin, Abraham. The significance of calcification in the ascending portion of the aortic arch. *Radiology*, Jan., 1954, *62*, 101–105.

Calcification in the ascending portion of the aortic arch is unusual in arteriosclerosis unless the disease is far advanced. The author has reviewed 95 cases diagnosed as syphilitic aortitis and in 54 of these calcification was found in the ascending aorta. Thirty cases showed evidence of aneurysm formation while the remainder did not. Thirty-three of the patients also had calcification present in the transverse and descending portions of the aortic arch.

One hundred sixty-three patients with arteriosclerosis of the aorta diagnosed during the same period of time as the above were also reviewed, but the author does not state how many of these were luetic or had calcification in the ascending portion of the aortic arch.

It is felt that as a result of the syphilitic process in the ascending aorta, a superimposed degenerative change occurs (arteriosclerosis) at a site where this type of lesion is not ordinarily prominent.

The author concludes with the statement that calcification in the ascending aortic arch is a reliable

sign of syphilitic aortitis. A technique is described for easy demonstration of this calcification.—*Donald N. Dysart, M.D.*

Schechter, M. Murray. The superior vena cava syndrome. *Am. J. M. Sc.*, Jan., 1954, *227*, 46–56.

The author presents a series of 22 cases of superior vena cava syndrome caused by obstruction of the superior vena cava.

The major manifestations include cyanosis and edema of the face, neck and upper extremities, markedly elevated venous pressure in the upper extremities with a normal venous pressure in the lower extremities and distention of the superficial veins of the upper portion of the body with the flow being caudad.

Almost all cases of superior vena caval obstruction by intrathoracic malignant tumors are caused by direct invasion of the venous wall by tumor tissue. A considerable decrease in the incidence of obstruction caused by aneurysms of the ascending aorta is found. Techniques for aiding in diagnosis and localization of obstruction are described.

Intracranial hemorrhage is relatively rare, due to the ability of the veins to dilate.

Eleven per cent of the author's series of carcinoma of the lung produced superior vena cava obstruction.

The four main routes of collateral circulation are described in detail: (1) the azygos route, (2) the internal mammary route, (3) the lateral thoracic route and (4) the vertebral route.

The author's 22 cases of superior vena cava obstruction are discussed at some length.—*C. Peter Truog, M.D.*

Abdomen

Burkhead, Howard C., Swan, Verner, and Dorsey, John M. Paraganglioma of the stomach; a case report. *Radiology*, Dec., 1953, *61*, 944–946.

The authors present the second case of paraganglioma of the stomach to appear in the literature. A paraganglioma is a chromaffin tumor occurring outside of the adrenal as contrasted to a similar growth within the gland.

A fifty-year old white male entered the hospital because of hematemesis and melena. He had been complaining of epigastric distress unassociated with meals. Roentgenologic examination of the stomach revealed a filling defect in the antrum which was suspected as representing a benign lesion. A gastrectomy was done and the patient made an uneventful recovery.

The authors state that the radiologist may be the first to suspect the diagnosis. Illustrations showing the roentgen, gross and microscopic appearance of the lesion are included.—*Everett E. Seedorf, M.D.*

Poppel, Maxwell H., Stein, Joseph, Jacobson, Harold G., and Lawrence, Lewis R. Megagastrica. *Am. J. Digest. Dis.*, Feb., 1954, *21*, 46–52.

The authors define megagastrica as a condition in which the stomach is enlarged to giant proportions, and not as simple enlargement or gastrectasia.

Etiologically they classify megagastrica into two major groups: organic and nonorganic. The organic group includes adhesions, inflammatory reaction in the pyloric region, tumor, extrinsic mass and hernia. The nonorganic group includes operative procedures, overloading of stomach, fractures, body spica application, poliomyelitis and other nervous system lesions.

The authors present the case histories of 7 patients with megagastrica and discuss the etiology of each. In 3 of the patients the cause was inflammation and scarring of the pyloroduodenal segment. One case occurred following vagotomy for a marginal ulcer; 1 occurred after application of a plastic spica; 1 was due to a large scrotal hernia with the stomach being part of the hernial content; and 1 occurred following a fracture of the spine with a transverse myelopathy.

Emphasis is placed on early diagnosis since untreated patients with hugely dilated stomachs will die.—*D. V. Campbell, M.D.*

Abel, W. Die Röntgendiagnose der Gastritis erosiva. (The roentgen diagnosis of erosive gastritis.) *Fortschr. a. d. Geb. d. Röntgenstrahlen ver. m. Röntgenpraxis*, Jan., 1954, *80*, 39–50.

Superficial erosions are fairly common in acute or chronic forms of gastritis and were found in 10 per cent of 389 patients with gastric or duodenal ulcers. The healing tendency of erosions is great but, under certain conditions, they may develop into ulcers. Demonstration of erosions requires careful fluoroscopy, minimal amounts of barium, little or no palpation, and a fasting or dry stomach. The symptoms of erosions are identical with those of ulcers even to the extent of massive or fatal hemorrhages and peritoneal reactions simulating a perforated viscus; however, mild bleeding is the rule as indicated by occasional finding of occult blood in the stools.

Erosive gastritis is recognized by the presence of a constant barium fleck or flecks in small round or oval defects with a thin translucent halo. Erosions vary in size and are occasionally strandlike or elongated. In hyperplastic gastritis, the erosions occur on thickened mucosal folds, which produce a granular or varioliform appearance.—*Joesph Zausner, M.D.*

Lame, Edwin L., Velat, Clarence A., and Custer, R. Philip. On the diagnosis of malignant lymphoma of the gastrointestinal tract. *Ann. Int. Med.*, Jan., 1954, *40*, 57–74.

During a five year period in a medium-sized general hospital an exceptionally large number of malignant lymphomas were identified in operative specimens from the gastrointestinal tract, representing 20 per cent of all malignant tumors removed from the stomach and nearly half of those from the small intestine. Lymphomas of the colon were numerically and proportionately low in incidence.

Preoperative diagnosis of gastrointestinal lymphoma is difficult and requires careful correlation of clinical, roentgenologic and laboratory data to be successful in a reasonable proportion of cases. For example, the combination of epigastric pain, anorexia, nausea and vomiting, without signs of obstruction, slight to moderate weight loss, presence of a palpable mass, little or no anemia, and roentgen evidence of a large and angry looking tumor of the stomach, should lead to a strong suspicion of gastric lymphoma. Roentgen study alone is mostly unsuccessful in the differential diagnosis; roentgenograms are reproduced from lymphoma, carcinoma and chronic gastritis that are virtually interchangeable.

Various types of gastric lymphomas are illustrated, including ulcerating lesions, polypoid tumors and infiltrative growths. Large lobular or whorl patterns or large rugae are not particular aids in differential estimate.

If the tumor found at operation is unresectable, the surgeon should remove a portion of the main mass for pathologic study, and not be content with biopsy of neighboring lymph nodes. Frozen section diagnosis of tumor tissue is unreliable.—*Paul R. Dirkse, M.D.*

Arneson, Wallace, A., and Ihle, Charles W., Jr. Congenital intrinsic obstruction of the duodenum; with report of three cases. *Ann. Surg.*, Jan., 1954, *139*, 95–98.

The authors report 3 successfully treated cases of congenital intrinsic duodenal obstruction. They note that the clinical signs of persistent vomiting, distention of the upper abdomen on the first or second day of life, and visible peristalsis, all point to some type of duodenal obstruction. They feel that abdominal roentgenograms should be done immediately. With atresia the stomach and proximal duodenum are gas filled and there is no gas in the remaining intestinal tract. In the stenotic cases some gas is usually visible in the small intestines. A thin mixture of barium does no harm and permits valuable localization of the obstructing lesion.

With early surgery and the proper supportive measures, a high percentage of cures can be expected in these cases.—*T. D. Allison, M.D.*

Hodes, Philip J., Pendergrass, Eugene P., and Winston, Norman J. Pancreatic, ductal, and Vaterian neoplasms: their roentgen manifestations. *Radiology*, Jan., 1954, *62*, 1–15.

The roentgen recognition of pancreatico-ampullary tumors depends upon their ability to distort the barium filled viscera that surround them. It is often difficult to differentiate them by roentgenologic means. The clinical history is of paramount importance in establishing a diagnosis and in making the differentiation. Pain, jaundice and loss of weight are cardinal symptoms. Vaterian tumors infiltrate the immediate environs of the ampulla and produce localized mucosal changes in the duodenum that are sometimes destructive. Tumors of the head of the pancreas disturb the distal end of the stomach, producing the "pad" sign described as a circumscribed filling defect along the greater curvature of the gastric silhouette. The authors seldom saw anterior displacement of the stomach as has been described by others. The duodenal bulb may also present the "pad" effect, may be displaced or may be distorted by a dilated common duct which compresses the bulb. The latter change is considerably discussed and emphasized. The significance of variations in motor activity is evaluated. Changes in duodenal motor activity and mucosal pattern are common with tumors in this region.

The paper is well illustrated with roentgenographic reproductions and diagrammatic drawings to demonstrate important features of diagnosis.—*Everett E. Seedorf, M.D.*

Singleton, Edward B. Intestinal obstruction in infants. *J. Pediat.*, Feb., 1954, *44*, 159–171.

The author outlines the difficulties in comparing infant and adult abdominal gas patterns in diagnosis of intestinal obstruction. Many cases are well illustrated and the typical roentgen findings are shown in the following lesions: duodenal atresia, annular pancreas, hypertrophic pyloric stenosis, congenital peritoneal band about distal duodenum, duplicated ileum, aganglionic terminal ileum (functional obstruction), meconium ileus, Hirschsprung's disease, imperforate anus and anorectal stricture. There are thirty-two excellent illustrations.—*Walter T. Hileman, M.D.*

Moore, Thomas C., and Stokes, George E. Congenital stenosis and atresia of the small intestine. *Surg., Gynec. & Obst.*, Dec., 1953, *97*, 719–730.

The authors present a detailed analysis of 40 cases of congenital obstruction of the small intestine observed at the Indiana University Medical Center between 1928 and 1953.

The necessity for early diagnosis and relief of obstruction is emphasized and the clinical studies, especially the history and the physical and roentgen examinations, utilized in arriving at a prompt diagnosis are detailed.

A survey film of the abdomen will indicate existence of obstruction and the necessity for surgical intervention in most cases. The findings on roentgen

and physical examination will generally suggest the level of obstruction.—*John F. Weigen, M.D.*

Kahle, H. Reichard, and Thompson, Clarence T. Diagnostic and therapeutic considerations of intussusception. *Surg., Gynec. & Obst.*, Dec., 1953, *97*, 693–701.

The article is a review and discussion of the general topic of intussusception with analysis of 71 cases seen at Charity Hospital, New Orleans, from 1939 through 1952.

Of the modalities available for diagnosis the clinical picture is of the most value by far, first because the symptoms and signs, and their chronology, are usually typical, and second because delay in diagnosis is the primary cause of death.

Laparotomy with manual reduction is the authors' treatment of choice and reduction by barium enema was used in only 6 cases, 3 of which also had laparotomy. In these 3 the reduction was found to be complete and the intestine appeared to be healthy. However, 1 of the 3 died nine hours after surgery due to gangrene of the affected segment. The fact that the intestine, which was subsequently not viable, was not identified as such even on direct vision indicates the greatest hazard to reduction by barium enema.

The authors feel that if reduction by barium enema is attempted it should be restricted to early cases, that the surgeon share in the decision to attempt the enema, and that surgery be performed in any case in which the reduction may not be complete, or routinely following the barium enema as Ravitch has suggested.—*John F. Weigen, M.D.*

Wilson, Francis W. Primary megacolon in young adults. *Am. J. Digest. Dis.*, Jan., 1954, *21*, 4–9.

A series of 11 young adults with primary megacolon is reviewed, 10 of whom were newly inducted into the Armed Services.

Primary megacolon can be diagnosed when there is no gross obstruction in the colon which might produce a dilated colon above it. Primary megacolon, in a sense, is due to a block in the colon even though it may be of functional or neurogenic origin. The condition is usually found in children and is presumed to be of a congenital or familial nature. A normal segment of colon is ordinarily seen in these cases just proximal to the rectum.

None of the above finding were present in the author's series. Most of these adults had mild symptoms and 4 had no symptoms referable to the gastrointestinal tract.

Investigation was initiated in 6 of the patients because of an abnormal gas shadow seen in the colon on routine chest roentgenograms, emphasizing the value of this examination in the presumptive diagnosis of megacolon. Chest roentgenograms on review were suggestive of megacolon in 9 of the 11 patients. Definite large areas of radiolucency could be seen in the left suphrenic area. One patient showed a marked shift of the heart to the right caused by the dilated colon.

The pertinent literature is reviewed and applied to various interesting aspects of megacolon which were observed in this series of patients.—*Wallace M. Roy, M.D.*

Barringer, Phil L., Dockerty, Malcolm B., Waugh, John M., and Bargen, J. Arnold. Carcinoma of the large intestine; a new approach to the study of venous spread. *Surg., Gynec. & Obst.*, Jan., 1954, *98*, 62–72.

From the Mayo Foundation and Clinic comes this description of a roentgenographic method for visualizing the venous bed in resected specimens of carcinoma of the large intestine.

A total of 45 specimens were examined by roentgengrams following instillation of brominol into major veins. In 23 instances, occluded vessels were thus detected while histological evidence of blood vessel invasion could be found in only 17.

Long term follow-up in these cases was not obtained and total evaluation of the method not secured, but the technique is introduced as an aid in detecting areas of possible venous occlusion for microscopic study. Since roughly 50 per cent of patients offered curative surgery for carcinoma of the large intestine develop and succumb to hematogenous metastases, a good method for detecting intravascular extension is of obvious prognostic importance.—*James A. Martin, M.D.*

Beddoe, Harold L., Kay, Saul, and Kaye, Sidney. Barium granuloma of the rectum; report of a case. *J.A.M.A.*, Feb. 27, 1954, *154*, 747–749.

Various agents such as talc, biotite, calcareous spar, cotton, etc. have been reported to cause foreign body granulomas in the alimentary tract.

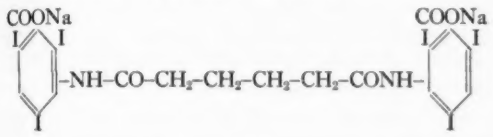
The authors report what is believed to be the first instance of a barium sulfate induced granuloma occurring in the intestinal tract (rectum) and discuss the possible cause of such a lesion.

This lesion presented itself in the form of a pedunculated tumor about 1 cm. in diameter approximately one month after gastrointestinal roentgenologic studies.—*George A. Miller, M.D.*

Sénèque, J., Le Canuet, R., Debray, Ch., Roux, Marcel, and Aussage, J. La cholangiographie par voie veineuse; sa place dans l'exploration radiologique des voies biliaires. (Intravenous cholangiography; its place in the roentgen examination of the biliary passages.) *Presse méd.*, Feb. 24, 1954, *62*, 281–285.

In 1924 tetraiodophenolphtalein was first used intravenously for cholangiographic purposes, but because of serious accidents it was discontinued completely. In May, 1953, Frommhold published his first results obtained with a new product; a few months later Teschendorf, and recently Hornykiewytsch, confirmed the innocuousness of the same opaque medium used intravenously.

The structural formula of this new preparation, which is called biligrafin, is as follows:



No enterohepatic cycle is observed as the product is not absorbable from the intestines. Normally 90 per cent of the substance passes through the liver, only 10 per cent being found in the urine. It is very slightly toxic and hitherto no untoward reactions have been observed. However, certain precautions should be taken. At the start the injection must be made very slowly almost drop by drop. If the sensitivity test to iodine is positive the precautions should be more strict. In hepatitis and cirrhosis no intravenous cholangiography should be attempted. Roentgenograms of the hepatic region are made at intervals of fifteen minutes for the first hour and every half hour thereafter. Maximum visibility of the principal biliary passages is obtained about the thirtieth and forty-fifth minute. The gallbladder is clearly visualized within an hour. Its maximum opacification is attained within two hours, this being superior to that seen in oral cholecystography.

The absence of the visualization of the principal biliary passages may be due to two main causes: (1) the product is poorly eliminated by a diseased liver parenchyma such as in the case of cirrhosis, hepatitis and various other jaundices; and (2) the elimination of the substance is done very rapidly by the biliary passages into the duodenum due to either surgical intervention at the sphincter of Oddi or choledochoduodenal anastomosis or fistula between the biliary and digestive tracts. The abnormal images of the biliary tracts as revealed by this intravenous method are essentially those of modification of the caliber, form, and position. The visualization of the calculi within the principal biliary passages is an important advantage. Insight as to function of the sphincter of Oddi and the pressure necessary to overcome it is thus obtained. Also more precise information is secured about the gallbladder and the causes of its nonvisualization or its sluggishness of elimination. After cholecystectomy intravenous cholangiography enables the visualization of the principal biliary ducts. —*J. N. Sarian, M.D.*

Nemours-Auguste, S., and Barag, N. Cholangio-cholécystographie; considérations préliminaires sur 100 observations—action pharmacodynamique. (Cholangio-cholecystography; preliminary remarks on 100 observations—pharmacodynamic action.) *Presse méd.*, Feb. 24, 1954, *62*, 300–304.

The roentgenographic visibility of the intra- and extrahepatic biliary ducts depends on the integrity of the hepatic function. According to Rosenthal, the minimum hepatic function corresponds to one-third of the surface of the liver.

After intravenous injection of the opaque medium, non-visualization of the biliary passages and delayed filling of the gallbladder were observed in cases of hepatitis, cholecystitis and cholelithiasis. The non-visualization of the biliary passages is reversible in curable hepatitis. Normally 10 per cent of the substance is eliminated directly by the kidneys and the urinary bladder can be visualized if emptied prior to the examination.

The common bile duct does not seem to change its caliber except after a Boyden meal which hastens the evacuation of the biliary ducts. It tends to empty by "levels," the inferior half level emptying first at irregular intervals. In case of non-visualization of the gallbladder, the common bile duct enlarges in trying to carry on the function of the gallbladder. Calculi within the common bile duct are visualized as negative shadows. However, special care should be taken to ascertain that there is no superimposition of the intestinal gas shadows.

Five minutes after injection of 1 cc. of morphine the intra- and extrahepatic ducts become visible and the common bile duct closes. No pain is complained of by the patient. In case of biliary colic in a cholecystectomized patient, inhalation of amyl nitrite relieved the pain completely and the biliary ducts were visualized after this inhalation. Injection of morphine or inhalation of amyl nitrite are of help in visualizing more clearly the biliary passages.—*J. N. Sarian, M.D.*

Berk, J. Edward; Karnofsky, Robert E.; Shay, Harry; and Stauffer, Herbert M. Intravenous cholecystography and cholangiography: report of preliminary observations. *Am. J. M. Sc.*, April, 1954, *227*, 361–371.

The need for a reliable non-surgical method of roentgenologically visualizing the major extrahepatic bile ducts has long been evident. The authors feel that oral cholecystographic media are generally unreliable for this purpose. A recently developed intravenously administered contrast medium which opacifies the extrahepatic bile ducts even when the gallbladder is diseased or has been removed has been under study by the authors since June, 1953. This material is known as Be-426 and is identical with biligrafin (Schering, A. G.) which has been investigated in Germany. It has an iodine content of 64.32 per

cent, and 9 per cent is excreted by the liver cells into the bile with only 10 per cent excreted by the kidneys. The concentration of the drug in the bile is considerably greater than that in the blood. This results in opacification of the larger bile ducts and subsequently the gallbladder. Eventually the drug reaches the intestinal tract with the bile and is eliminated in the feces.

In this study 30 subjects were used. Nine had intact gallbladders and 21 had undergone cholecystectomy. A test dose of 1 cc. of Be-426 was given intravenously and the subject observed for ten minutes. If no untoward reaction developed, 40 to 60 cc. of the material was then slowly injected intravenously over a period of eight to ten minutes. A roentgenogram was made immediately following the injection and serial roentgenograms were made every ten minutes for one hour and again at two hours. In 17 subjects a roentgenogram was made at three hours and in 9 at four hours.

The common duct could be detected in most cases on the ten and twenty minute films, and the intrahepatic biliary ducts and both hepatic ducts were frequently seen also. Maximal intensity of the common duct occurred twenty to forty minutes after injection with maximal intensity reached in two to two and one-half hours. The quality of the cholecystograms obtained was equal to that with the newer oral media. Prompt evacuation of the gallbladder occurred after a fat meal.

Opacification of the ducts in cholecystectomized individuals was sometimes disappointingly faint. The use of 60 cc. of the contrast medium often resulted in improved opacification. The terminal end of the common duct was usually not visualized and the administration of morphine sulfate, amyl nitrite, and intraduodenal HCl produced no improvement in visualization of this area. The compound could not be relied upon to visualize the ducts in jaundiced patients. No serious local or systemic reactions were observed in the group of patients studied.—*Arthur B. Smith, M.D.*

Twiss, J. Russell, Beranbaum, Samuel A., Gillette, Lee, and Poppel, Maxwell H. Post-cholecystectomy. Oral cholangiography: a preliminary report. *Am. J. M. Sc.*, April, 1954, *227*, 372–386.

This report deals with 31 patients investigated by oral cholangiography. Of 18 patients with biliary tract symptoms following cholecystectomy, 15 showed a visualization of the bile ducts. Of 7 post-cholecystectomy patients without symptoms, 6 visualized the bile ducts. Of 4 patients without symptoms who had had a choledochoduodenostomy, none visualized the bile ducts. Of 2 patients having a non-functioning gallbladder or "physiologic cholecystectomy," 1 visualized the common bile duct.

The technique of the examination is as follows: 6 tablets of a 3-molecule iodine preparation (telepaque used in most of these cases) are taken at intervals of five minutes, beginning at 6 P.M. After the last tablet, one teaspoonful of paregoric is given. The total amount of water taken is not to exceed one-half glass.

At 11 P.M. the above procedure is repeated.

At 8 A.M. one teaspoonful of paregoric is given with a swallow of water, otherwise no water is taken at any time until the completion of the test.

At 10 A.M. exposures of the right upper quadrant are made in the posteroanterior and oblique projections at a 36 inch target-film distance.

If the bile ducts are visualized an inhalation of amyl nitrite is given, with the patient in the recumbent position, and further exposures are made at fifteen and thirty minute intervals. If there is no emptying of the bile ducts a fat meal is given and another exposure made in thirty minutes.

The interpretation of the films is based upon the degree of visualization, the diameter of the common bile duct and the response to amyl nitrite, or the fatty meal, or both. The degree of visualization is noted as none, faint, fair, or good. The uppermost limit of the caliber of the average post-cholecystectomy bile duct is provisionally considered to be 6 mm. Diameters from 7 to 10 mm. are considered slight dilatation, 11 to 20 mm. moderate dilatation, over 20 mm. marked dilatation. The lack of response to amyl nitrite or the fat meal is presumptive evidence of organic obstruction of the ampulla of Vater or the common duct sphincter.

Indications for oral cholangiography are (1) post-cholecystectomy syndrome and (2) non-visualization of the gallbladder.

The bile ducts were visualized in approximately 85 per cent of post-cholecystectomy patients, exclusive of those having had a subsequent choledochoduodenostomy.

With biliary dyskinesia, about 70 per cent of the bile ducts visualized were dilated. In post-cholecystectomy patients without symptoms, none of the bile ducts were significantly dilated.

Cystic duct remnants can also be detected by this method.—*Arthur B. Smith, M. D.*

Stirrett, Lloyd A., and Yuhl, Eric T. New method for determination of gall-bladder function. *A.M.A. Arch. Surg.*, April, 1954, *68*, 417–421.

The authors describe the results of their studies of the gallbladder function in 102 patients following intravenous injection of a single dose of radioactive diodofluorescein (DIF) using 5/μc per kg. bodyweight as a tracer and the scintillation counter to detect gamma radiation from the I^{131}.

DIF has been used extensively in other investigations and no toxic side reactions have been observed. It is rapidly eliminated from the blood stream, and

is excreted by the liver. It appears in the bile ducts ten minutes after injection and reaches maximum concentration in thirty to sixty minutes. The patient is placed under the scanner thirty minutes after injection, and the entire upper quadrant is scanned. The resultant record is called a scintigram.

In patients with a normal gallbladder a scintigram shows a high concentration in the gallbladder area thirty to sixty minutes after injection. Repeated scans at thirty minute intervals show gradual decrease in the concentration of radioactivity over the gallbladder area. At the end of two hours only slight traces can be detected.

The accuracy of this method was tested on 26 patients who had a normal cholecystogram. These patients had a laparotomy for other than gallbladder disease. At operation the gallbladder was found to be normal. In the diseased gallbladders there was poor concentration or non-visualization of the gallbladder after oral cholecystography. There were corresponding confirmatory changes on the scintigram.

The authors feel that scintigraphy offers a reliable index of gallbladder function and may be performed when there is no time for oral cholecystography, or when the patient is vomiting and is unable to retain orally administered medication.

The chief limitation of this method, however, is the inability to visualize calculi.—*William H. Shehadi, M.D.*

Douglass, Thomas C., Lewis, R. Burns, and Mehn, W. Harrison. Operating-room cholangiography; errors in technique and interpretation. *A.M.A. Arch. Surg.*, April, 1954, *68*, 422–431.

The authors present a critical study of 108 cholangiographic examinations done in the operating room, with special evaluation of 37 cholangiograms which in some way were imperfect.

The examinations conducted in the operating room were made with a 25 ma. portable roentgen machine. A Camp-Lysholm grid cassette was used to hold the film and was placed in a tunnel under the patient before the operation was started.

Diodrast (iodopyracet 35 per cent) was the contrast medium used, injected through a catheter, polyethylene tube or a T tube. The first exposure was made after injection of 5 cc., and the second after injection of 15 cc.

The authors list the causes of imperfections in a cholangiogram, and stress the importance of close cooperation between the surgeon, the anesthetist and the roentgen technician.

The technical errors which are preventable are: (1) Respiration during the exposure. This is over come by inducing an apneic period by hyperventilation of the patient. This method is safer though more difficult than the intravenous administration of pentothal. The experience of the anesthetist is paramount in obtaining the maximum results with this procedure. (2) Duodenal injection occurring when the tube passes through the ampulla and no reflux of the contrast medium into the biliary tract will occur. (3) Air bubbles in the biliary tract simulating calculi. (4) Incomplete filling due to use of inadequate amounts of contrast medium or to pressure by laparotomy pads or distended stomach. (5) Rapid emptying between injections and before an exposure is made. (6) Mechanical failures of the roentgen equipment at the time of the examination. (7) Leaking of the contrast medium which can be prevented by tightening the tubing to the cystic duct or, by tightly suturing the common duct around the T tube. (8) Interposition of instruments and grounding plates. (9) Errors in interpretation. Translucent areas believed to be air were noted in 11 cases. This proved correct in 9 cases, while in 2 cases they were due to calculi.

The authors caution against the use of morphine preoperatively because of resultant sphincteric spasm which may mask a pre-existing spasm or simulate other conditions. This will not occur with the use of barbiturates.

Relaxation of the spasm may be obtained by injecting 10 cc. of 1 per cent procaine mixed with 20 cc. of diodrast.

The above listed technical errors do not detract from the value of the method. Routine use of this method brings about greater efficiency and fewer errors.—*William H. Shehadi, M.D.*

Harris, Ruth C., and Caffey, John. Cholecystography in infants. *J.A.M.A.*, Dec. 12, 1953, *153*, 1333–1337.

Roentgen visualization of the gallbladder of children under the age of three years has been generally unsatisfactory. This is a report of the progress being made in the study of gallbladder function in infants.

The appearance of the gallbladder shadow after the oral administration of radiopaque material depends on adequate absorption, active secretion of the medium by the liver into the bile ducts, and concentration within the gallbladder. With these facts in mind, the authors studied 27 cholecystograms of 25 infants under three years of age. There were 15 successful visualizations of the gallbladder. Among 12 infants under six months of age, given priodax or telepaque, visualization was successful in 6. The opaque medium was given orally in dosage of 0.15 gm. per kilogram of body weight, and films were exposed hourly for ten hours. The gallbladder shadow was most distinct in the majority of cases between four and nine hours after the administration of the contrast material.

The technique of examination was as follows: (1) nothing orally after midnight; (2) at 6 a.m., powdered opaque medium mixed with 2 or 3 teaspoonfuls of orange juice; (3) no food or fluid during the next

eight hours and then orange juice or Karo water if the study was to be continued; (4) hourly roentgenograms both in the frontal and left anterior oblique positions. In an attempt to improve the concentration of the opaque medium, sodium bicarbonate was given to raise the intestinal pH and so increase absorption. This was of no particular value. Urokon, 70 per cent, given intravenously failed to opacify the gallbladder of 3 infants. Giving 3 doses of telepaque at twelve hour intervals did improve visualization and caused no toxic effects.

The authors feel that generally it is necessary to make serial exposures earlier in young children than in adults, to obtain better cholecystograms.—*S. A. Kaufman, M.D.*

Wieser, C. Nouvelle méthode de volumétrie au cours de l'épreuve d'évacuation en cholécystographie. (New volumetric method of studying gallbladder emptying in cholecystography.) *Schweiz. med. Wchnschr.*, Jan. 23, 1954, *84*, 149–153.

The area of the gallbladder is measured in right angle projections. The area of the intersecting plane is calculated as the square root of the sum of the squares. The volume of the gallbladder is assumed to vary as the cube of the linear dimension or the square root of this intersecting plane. Verification of the method on models confirms the need for the two views. The formula used is $V = KS^{3/2}$ where V is the volume, S the area of the intersecting plane and K a constant found to be 1/2.36 with a variation of ±11 per cent.—*M. L. Sussman, M.D.*

Ryan, Ernest A., Harrigan, E., and Penny, S. F. Acute gaseous cholecystitis. *Canad. M.A.J.*, Dec., 1953, *69*, 606–610.

The authors give a brief review of the literature with a discussion of treatment used in the less than 35 cases collected.

An additional case is reported in detail of a male seventy years of age in whom the correct diagnosis was made from the clinical findings and a flat roentgenogram of the abdomen. Gas was visualized distending the gallbladder with additional gas outlined that later was proved to be in the wall of the gallbladder.

The patient was given large doses of procaine penicillin preoperatively. The gallbladder was then carefully removed and penicillin with streptomycin was given postoperatively.

The authors believe that aspiration at the time of surgery would not have added to the risk of infection and would have facilitated the surgery.

Perforation invariably occurs in untreated acute gaseous cholecystitis. The growth of the gas-forming organism is secondary to, and not responsible for, the acute cholecystic process.—*V. L. Peterson, M.D.*

Pietri, H., and Massonnat, J. Intérêt du pneumopéritoine dans l'étude radiologique des foies cirrhotiques. (Values of pneumoperitoneum in the roentgen study of cirrhotic livers.) *Arch. mal. app. digest.*, Feb., 1954, *43*, 159–167.

After withdrawal of ascitic fluid and injection of air, roentgenograms are made to illustrate the size and shape of the liver and even to demonstrate esophageal varices following barium swallow in a more distinct manner.

Experiments have also been done utilizing transsplenic portal venography following pneumoperitoneum. After removal of ascitic fluid and injection of air, the contrast medium is injected into the spleen and outlines the portal system.—*Charles Nice, M.D.*

Bourgeon, R., Pietri, H., and Guntz, M. Intérêt de la splénoportographie transplénique dans l'échinococcose hépatique. (Value of transsplenic splenoportography in hepatic echinococcosis.) *Arch. mal. app. digest.*, Feb., 1954, *43*, 168–176.

This article consists of a presentation of 4 cases with echinococcus cyst of the liver which had the transsplenic method of portovenography. The reproductions of the roentgenograms and illustrated drawings depict the displacement of vessels produced by the cysts in the liver.—*Charles Nice, M.D.*

Genitourinary System

Chávez, Luis Meza, and Villasana E., Antonio. Tumores del testículo. (Tumors of the testicle.) *Rev. urol.*, Mexico, Jan.-Feb., 1954, *12*, 1–14.

A simplification of Dixon and Moore's classification of testicular tumors is proposed. In order of increasing malignancy there are: (1) seminoma, (2) teratoma, (3) embryonic carcinoma and (4) choriocarcinoma. When a certain tumor shows two or more components it is classified according to the most malignant one. It is to be noted that when teratomatous areas are observed in an embryonic carcinoma or choriocarcinoma the prognosis is a little better than if it were a pure type.—*Francisco Comas, M.D.*

Aguilera, Salvador Salinas. Diagnóstico clínico de los tumores testiculares y radiológico de sus metástasis. (Clinical and radiological diagnosis of testicular tumors and its metastases.) *Rev. urol.*, Mexico, Jan.-Feb., 1954, *12*, 15–20.

The first symptom of testicular tumors is in most cases enlargement of one testicle. Pain, due to pulling of the spermatic cord, is mild or altogether absent. Sharp pain occurs when the cord is twisted or with rupture of the albuginea with sudden hema-

tocele. On examination, the testicle appears somewhat enlarged, hard, movable and not tender. Its normal shape is preserved in early tumors; it becomes irregular and bosselated later on. The epididymis is only invaded in advanced stages. Hydrocele and hematocele occur and may pose difficult diagnostic problems. Cryptorchid testicular tumors in the inguinal canal produce symptoms and signs similar to those in fully descended testes. Intra-abdominal testicular tumors often acquire a huge size before they cause any symptoms.

Retroperitoneal lymph node metastases may be palpable in thin patients. Roentgenologically they can be visualized on flat films of the abdomen, but are best demonstrated with intravenous pyelography, where displacement of the ureters and sometimes evidence of hydronephrosis are well manifested. Retropneumoperitoneum will show the metastatic lesions still more clearly. Sometimes the retroperitoneal masses cause displacement of the colon that is evident in barium enema. Routine roentgenologic study of the skeleton has little value, since only 2 per cent of testicular tumors metastasize to bones.—*Francisco Comas, M.D.*

Castro, Eduardo. Cirugía de los tumores testiculares. (Surgery on testicular tumors.) *Rev. urol.*, Mexico, Jan.-Feb., 1954, *12*, 21–24.

The role played by surgery in the treatment of testicular tumors is limited. It consists of the removal of the affected testis which provides for histopathological classification. A simple biopsy should never be undertaken. If on clinical grounds there are doubts about the nature of the testicular mass one can explore the testicle surgically, proceeding with extreme care and gentleness. If with the testicle in view the diagnosis cannot yet be established it would be justifiable to remove it for diagnostic purposes. Dissection of the retroperitoneal lymph nodes, from the femoral artery to above the renal pedicle, has been attempted in radioresistant tumors, although unfortunately such an extensive operation has been attended with a very small number of cures.—*Francisco Comas, M.D.*

Limón, José Noriega. Tratamiento radioterápico de los tumores testiculares. (Radiotherapeutic treatment of testicular tumors.) *Rev. urol.*, Mexico, Jan.-Feb., 1954, *12*, 25–35.

For purposes of radiation therapy testicular tumors are divided into two groups: seminoma and nonseminoma; in the latter are included mixed tumors that have a seminoma component. Although embryonic carcinoma, choriocarcinoma and teratoma may occasionally be cured by irradiation it is only in seminoma that a high cure rate can be expected.

The primary tumor should be excised and radiation therapy directed to the lymph node drainage area. Preoperative radiation therapy given with the intention of testing the radiosensitivity of the tumor may lead to erroneous conclusions or it may make difficult the interpretation of the histopathological picture and delay treatment.

In cases with no clinically or roentgenologically demonstrable metastases the treated area measures 10 cm. in width and extends from the external opening of the inguinal canal to the level of the 10th dorsal vertebra. If the tumor is on the left side the anterior and posterior fields cross the midline 2 cm. to the right. If abdominal metastases are present the field of irradiation includes the whole abdomen. If the general condition of the patient allows it the mediastinum and left supraclavicular area are prophylactically irradiated. In the abdomen it is intended to deliver 3,000 r to a plane passing 1 cm. in front of the vertebral bodies in five or six weeks.

Seminoma is an extremely radiosensitive tumor in which the hope of cure should not be abandoned even with extensive and disseminated metastases; it warrants a thorough irradiation.—*Francisco Comas, M.D.*

Kimbrough, James C., and Cook, Ferris E., Jr. Carcinoma of the testes. *J.A.M.A.*, Dec. 19, 1953, *153*, 1436–1438.

The authors present their experiences with 106 cases seen since World War II at Walter Reed Army Hospital.

Painless enlargement of the scrotum and heaviness of the involved testis on palpation were the usual findings. A metastatic lesion, however, was at times the first indication of testicular neoplasm.

Seminomas which made up 35 per cent of the testicular tumors were generally radiosensitive. However, more than a third of metastases of seminoma were of a radioresistant type—embryonal, teratomatous or some other highly malignant form. Thus, the authors state, "Cancer of the testis is totipotent."

Teratocarcinoma, embryonal carcinoma, and teratoma constituted 35, 19 and 7 per cent, respectively, of the remaining types. These tumors on the whole were radioresistant.

A plan of therapy is given which evolved from these experiences. Because of the totipotent nature of the sex cell, radiation therapy alone is not considered dependable for malignancy of the testis. When there is no evidence of extension outside the retroperitoneal space, radical orchiectomy is performed (including resection of the spermatic cord and vessels and the retroperitoneal lymphatics). Postoperative irradiation of all seminomas and those radioresistant tumors with extension into the retroperitoneal region is then carried out. Radioresistant tumors without extension are not given postoperative irradiation.

Resection of solitary pulmonary metastases following radical orchiectomy was done in 4 cases. The results were considered promising in 2 of these.

In the presence of extensive metastases, orchiectomy, estrogens, and radiation therapy were employed. Metastases receded and pain was relieved in the 3 cases in this category so treated.—*Thomas B. Efford, M.D.*

Couvelaire, R., Lardat, M., and Hy, Ngo Gia. Essai de classification des cystographies du tuberculeux génito-urinaire. (Tentative classification of cystographies in genitourinary tuberculosis.) *J. d'urol.*, 1953, *59*, 815–844.

In the authors' opinion, disregard of bladder appearance on secretory pyelograms leads to decrease in diagnostic efficiency. Their morphologic classification is based on about 400 cases of tuberculosis. Under (1) vesical outline are grouped (a) the invisible bladders (25 cases), due to delayed secretion and/or continuous evacuation, indicative of poor prognosis; (b) normal bladder (225 cases), including 87 cases of proved specific cystitis; (c) large bladder (5 cases) caused, in the absence of prostatic obstruction, by tuberculous dyskinesia of the vesical neck; (d) round bladder (38 cases), the result of increased tonicity of the intrinsic musculature, *i.e.*, a reversible condition; (e) asymmetric bladder (63 cases) and (f) indented bladder (21 cases,) produced by organic changes in the bladder wall, with (g) small bladder (26 cases) representing the final stage of parietal sclerosis. (2) The bladder content of contrast medium may appear (a) homogeneous, but also (b) trabeculated (cystitis); it can reveal (c) pseudotumoral filling defects (calculi, hypertrophic cystitis, organized clots) or simulate (d) marble bladder (false membranes). As a rule, (3) the intrinsic musculature of the bladder is not seen, yet at times it is visualized as a double contour, a phenomenon not fully explained and seemingly associated with hypertrophic changes. Also discussed are alterations in the (4) terminal ureter, either intrinsic or extrinsic obstruction with proximal dilatation, and in the (5) vesical neck, a rarely seen funnel shaped deformity, encountered in hypertonic bladder with extreme pollakiuria.

In the second part of the paper, the morphologic aspect of "secretory cystograms" obtained in genitourinary tuberculosis is correlated with the underlying pathology, by comparison with the findings on retrograde cystography, cystoscopy, laboratory study, clinical examination, surgery and autopsy. Some of the reproduced films actually represent retrograde cystograms, and caution is expressed concerning overinterpretation of an incompletely filled bladder.

In the last part, an attempt is made to consider the "large," "round" and "indented" bladders in the light of the respective therapeutic indications, from the conservative streptomycin, isonyazid and P.A.S., through nephrectomy and vesical decortication, to cutaneous ureterostomy, ureterocolic implantation and enterocystoplasty. Roentgenograms cannot (and should not) be used to decide upon an operation, thus final evaluation must by necessity include data collected by all means at one's disposal. The authors' conclusive statement is that intravenous urograms should be scrutinized just as carefully below, as they are above the cystoureteral junction.—*E. R. N. Grigg, M.D.*

Kika, Kanji. A clinical analysis of the "angiograms" found in the course of hysterosalpingography with special reference to tuberculosis of the female genitals. *Am. J. Obst. & Gynec.*, Jan., 1954, *67*, 56–63.

Hysterosalpingography is at present to be regarded as about the most important and useful diagnostic method for the study of sterility in women. Many untoward complications have occurred, one of which is called an "angiogram." It is represented by the unusual phenomenon of the passage of the oil-soluble contrast medium into the myometrium, vascular and lymphatic systems.

Fifty-two cases of uterine "angiograms" were selected from 1,200 hysterosalpingograms taken of sterile women. The author employed an iodized oil (20 to 40 per cent of moliodol), 4 to 8 cc. in amount, injected with pressure of less than 100 mm. of mercury. The films were exposed at five minutes and twenty-four hours after the injection. In certain cases the phenomenon was directly observed under the fluoroscope. Forty-five of these cases were examined for tuberculosis with the aid of repeated cultures for tubercle bacilli from the vaginal content or menstrual blood and from uterine douche fluid as well as cervical or endometrial biopsies. In operative cases the removed tissue was examined histopathologically and bacteriologically.

Of the 45 patients investigated for tuberculosis, 32 cases were confirmed. The diagnosis was presumptive in 7 cases and in 6 cases no evidence of tuberculosis was found.

Among the 32 cases of tuberculosis, there were 20 cases of amenorrhea and 4 of menstrual disturbance. The most prominent microscopic feature of the removed uterus was the inflammatory change typical of tuberculosis of the endometrium and myometrium.

The untoward reactions associated with the "angiograms" were the following: When the hysterosalpingogram was performed about half of the patients complained at once of smelling the iodized oil, a sensation lasting about thirty seconds. In addition, there were noted faintness, lassitude, and anorexia. A rise in temperature with chills followed the procedure in 4 cases. Neither infarct by oil embolism, nor iodism, nor irritable cough was ever observed. It is believed that an "accidental" excessive pressure, too much iodized oil, variation in phases of the menstrual cycle and ligated tubes have little responsibility for the production of this condition.—*Robert K. Arbuckle, M.D.*

Finkle, Alex L., Prince, Charles L., and Scardino, Peter L. On the incidence of

calcified uterine fibroids. *Am. J. Obst. & Gynec.*, Jan., 1954, *67*, 79–84.

The authors report 5 cases of calcified fibromyomas of the uterus in a series of 4,000 genitourinary tract studies. In 4 of these bladder symptoms were prominent and all 5 cases presented varying degrees of lower abdominal discomfort. All of the patients except 1 were over fifty years of age. The authors conclude from this study that calcification in uterine fibroids is a benign process in itself and only produces symptoms by pressure effects on nearby structures. —*T D. Allison, M.D.*

Skeletal System

Wilson, James N. Profiles of the carpal canal. *J. Bone & Joint Surg.*, Jan., 1954, *36-A*, 127–132.

Wilson states that some injuries and abnormalities of the carpal bones may be easily overlooked at routine roentgenographic examination. The most superficial of the bony prominences in the palm and consequently those most vulnerable to direct trauma consist of four anterior projections or pillars. These are represented on the radial margin by the tubercle of the navicular and the ridge of the greater multangular, and on the ulnar border by the pisiform and the unciform process of the hamate. The transverse carpal ligament spans between these pillars and thus converts the carpal canal into an osseofibrous tunnel. Through the tunnel pass nine digital flexor tendons and the median nerve. The tendon of the flexor carpi radialis also passes through the tunnel but lies within a separate synovial compartment.

The roentgenographic outline of the bony pillars and their relationship to the carpal canal are well seen with an axial projection of the base of the palm. While the volar surface of the wrist is held against the cassette, the wrist is dorsiflexed 60 degrees and the central ray is directed along the longitudinal axis of the third metacarpal. The osseous outline of the carpal canal is thus shown in profile.

Roentgenograms are reproduced which reveal a fracture of the base of the hook of the hamate; an anterior dislocation of the lunate; a congenital division of the capitate; encroachment of the carpal canal by an anomalous capitate; failure of fusion of a separate ossification center of the hamate hook; and an avulsion fracture at the point of insertion of the transverse carpal ligament of the ulnar margin of the ridge of the greater multangular. In another case the roentgenogram revealed calcification in the pisiform bursa.

In his summary, the author again emphasizes the importance of the profile view in identifying certain injuries and developmental disturbances of the carpus since standard roentgenographic views of the wrist do not reveal some of the fine details of the carpal bones.—*Ralph S. Bromer, M.D.*

Sidbury, James B., Jr., and Sidbury, J. Buren. Infantile cortical hyperostosis; an inquiry into the etiology and pathogenesis. *New England J. Med.*, Feb. 25, 1954, *250*, 309–314.

The development of fever, irritability, and swelling over the involved area of bone in a child under five months of age is characteristic of this disease. It was first reported by Roske in 1930 but the syndrome was not appreciated until the publication of the clinical and roentgenologic picture by Caffey and Silverman in 1945 and Caffey in 1946.

Ten cases are reported, the age varying from birth to four months. All of these cases recovered with slight residual deformity of some of the severely involved long bones in two. This makes 69 cases that have been reported in detail in the literature. In addition, Caffey reported 12 cases which were not individually listed.

Although there were no deaths in this series, there have been 4 recorded deaths in the literature, 3 from infection and 1 in which the cause was unknown. There have also been 3 unreported deaths, 1 apparently from infantile cortical hyperostosis and the other 2 from unknown causes.

The authors conclude that the etiologic factor in this syndrome is an inherited defect of the arterioles supplying the affected areas. This results in hypoxia, causing focal necrosis of the overlying soft tissues and proliferative reaction of the periostenum.—*Neal F. Yeomans, M.D.*

Graffeo, L. W., Tisdall, L. H., and DeVita, J. R. Osteogenesis imperfecta; a case report. *Am. J. Obst. & Gynec.*, Dec., 1953, *66*, 1333–1336.

Osteogenesis imperfecta congenita or tarda has been described variously as Vrolik's syndrome, fragilitas ossium, Lobstein's disease and osteopsathyrosis. Fragile bones predispose to numerous fractures. The same patients have blue scleras, otosclerosis and relaxed ligaments. With the congenital form the fetus is usually dead or dies soon after birth.

The authors report the occurrence of this condition in female members of at least three consecutive generations. Yater reported the disease in seven successive generations. The abnormal genesis of bone seems to be a developmental defect of mesenchyme with an estimated incidence of 1 in 7,951 to 1 in 30,000 deliveries.

Pelvimetric studies showed changes in the mother's bones from osteogenesis imperfecta and showed a fracture of the left femur of the fetus. The mother in the case reported and the female baby survived. A second delivery eighteen months afterward resulted in a normal baby.—*John W. Turner, M.D.*

Jaffe, Henry L. Osteoid-osteoma. *Proc. Roy. Soc. Med.*, Dec., 1953, *46*, 1007–1012.

Osteoid-osteoma evolves slowly, and often gives rise to clinical complaints for many months before its presence is demonstrable on the roentgenogram at all, and even longer before the roentgen appearence is reasonably clear cut. The evolving lesion has two components: (1) the core or nidus-like focus, and (2) the reactive perifocal zone of bone thickening.

Careful technique in the taking of roentgenograms is essential, including sufficient penetration of bone, multiple angles and sharp detail.

The etiology of osteoid-osteoma is in doubt and the lesion may involve any bone though it is rarely seen in a vertebral body.

A brief summary is given of 12 cases. The lesion is more common in men and is most often seen in the age group between ten and twenty-five years. Pain is the presenting symptom. Surgery is the treatment of choice and requires the complete removal of the nidus to prevent recurrence. A single case is noted in which pain was relieved by roentgen treatment; however, pain recurred after three years and required removal of the nidus that had persisted. An additional case is mentioned in a girl operated on for an osteoid-osteoma at the age of three and a recurrence was removed at the age of seventeen.—*V. L. Peterson, M.D.*

Naylor, A., and Chester-Williams, F. E. Myelomata of bone; a review of 25 cases. *Brit. M. J.*, Jan. 16, 1954, *1*, 120–124.

The authors present 25 cases of myeloma of bone. In their experience this disease appears twice as frequently as osteogenic sarcoma.

The disease exists in three forms: (1) a solitary form in which a large tumor is present; (2) a diffuse form in which the lesions are small and cause diffuse decalcification of the affected bone; (3) a multiple form into which the others usually develop when the plasma cells are aggregated into discrete nodules forming localized osteolytic lesions.

The following procedures are recommended for proper study of the patient: roentgenography of the skull, ribs and vertebrae; determination of total serum proteins and serum albumin and globulin; examination of urine for Bence-Jones proteose; and sternal marrow aspiration. The authors stress the fact that negative results in the above tests do not exclude the disease.

In general, solitary myeloma occurs in the younger age group (average 40 years), favors males 3 to 1, and usually develops into the multiple form. The diffuse form occurs in patients over sixty years and is the most difficult to diagnose. The multiple form represents the end stage of the disease and is analogous to the condition of general carcinomatosis.

Treatment available at present has little to offer as far as the ultimate fate of the patient is concerned. Deep roentgen therapy has a definite place in the relief of pain and may prevent the onset of paraplegia when given to affected vertebrae.—*Robert E. Flynn, M.D.*

Reeves, Robert J., and Pedersen, Robert. Fungous infection of bone. *Radiology*, Jan., 1954, *62*, 55–60.

In a series of 40 cases of fungous disease of the bone the authors found 23 of them accounted for by blastomycosis. Actinomycosis accounted for 16 and cryptococcosis for one. Other fungous diseases found in bone are coccidioidomycosis and sporotrichosis.

Skeletal blastomycotic involvement may occur either by direct extension or by hematogenous spread from an unknown portal of entry. The epiphyseal ends of long bones, the joints, vertebrae and ribs are the areas chiefly affected. The roentgenographic findings are variable and may simulate very closely those of coccidioidomycosis. A consistent feature is a sharp line of demarcation between the involved area and the adjacent normal bone. The prognosis is variable with death coming in six to eight months or patients surviving up to thirteen years.

Actinomycosis, a chronic granuloma, is found most commonly in the head and neck with bone involvement almost invariably occurring as a result of direct extension from the adjacent soft tissues. The dorsal vertebrae may be involved by extension from the lungs and the lumbar vertebrae from the abdominal viscera. Vertebral body collapse is rare and usually the disc is undamaged.

Cryptococcosis, often called torulosis, causes bone lesions which are quite similar to those of blastomycosis and coccidioidomycosis. Roentgenograms show widely disseminated and discrete destructive lesions surrounded by a well marked zone of proliferation of bone.

Coccidioidal granuloma is usually manifested as a purely destructive process with either sharply or poorly defined margins. There may be diffuse osseous involvement. The roentgen appearance is not characteristic and may be confused with that of tuberculosis, syphilis, osteomyelitis, actinomycosis, blastomycosis and metastatic cancer.

Another granulomatous disease, sporotrichosis, usually affects visceral and bony structures with involvement of the joints, articular surfaces and synovial membrane. Accompanying skin lesions are almost always present.—*Donald N. Dysart, M.D.*

Lackner, J. Zur Röntgendiagnostik polytoper enchondraler Ossifikationsstörungen, bes. der Dysostosis multiplex Pfaundler-Hurler, der Knochenchondromatose und der Chondroangiopathia calcarea. (Roentgen diagnosis of polytopic enchondral ossification disturbances, especially dysostosis multiplex of Pfaundler-Hurler, osteochondromatosis and chondroangiopathia calcarea.) *Fortschr. a. d. Geb. d. Röntgenstrahlen ver. m. Röntgenpraxis*, Feb., 1954, *80*, 165–180.

Two new cases of chondroangiopathia calcarea

(synonyms: chondroangiopathia calcarea congenita, chondroangiopathia punctata, chondroangiopathia calcificans congenita, stippled epiphysis) are reported. This disease is characterized by a disturbance of the vascularization of the cartilage of the epiphysis and the cartilaginous anlage of the short bones of hands and feet, being still undetermined whether the faulty anlage of the cartilage or of the blood vessels is the primary.

One case of chondromatosis is also reported. In this case the pathologic changes were limited to the right lower extremity (oligotopic, monomelic type). The historical development of research of the dysostoses, especially of the dysostosis multiplex of Pfaundler-Hurler, is discussed. On the hand of the material of 10 cases, the roentgen findings are described. The difficulties of differential diagnosis are emphasized. Present classifications of dysostoses are more confusing than helpful in diagnosis. A revision is highly recommended. New classifications should be established by close cooperation of clinician and roentgenologist. To avoid a further increase of the present confusion, all cases in which the roentgen findings do not correspond to Pfaundler-Hurler's disease should be filed under the general heading of "dysostoses."—*Hans Lewin, M.D.*

Storsteen, Kenneth A., and Janes, Joseph M. Arteriography and vascular studies in Paget's disease of bone. *J.A.M.A.*, Feb. 6, 1954, *154*, 472–474.

Arteriovenous fistulas may be present in Paget's disease of bone. The increased blood flow in the involved bone with the resultant increased cardiac output produces a decrease in cardiac reserve which predisposes to cardiac enlargement and failure.

Three cases with involvement of the lower extremities were studied and are reported in detail. In the first patient, arteriograms of the involved lower extremity were made. In the second patient, both arteriograms and special vascular studies, including determination of femoral venous pressure, studies of circulation with Evans blue and simultaneous measurements of the oxygen content of blood in both femoral veins were done. Only the special vascular studies were carried out in the third patient. Both arteriograms showed increased vascularity of the involved extremities. Circulation times were normal. The authors believe that this does not exclude small arteriovenous communications. In their second case, a slight increase was noted in venous pressure together with a substantial increase in the venous oxygen saturation of the affected extremity and in the third case only a slight increase of venous oxygen saturation of the affected extremity was observed. It was postulated that the early and minimal involvement of bone in the third case was insufficient to cause a more definite abnormality.

It is concluded that multiple small arteriovenous fistulas are probably present in Paget's disease of bone, and that the symptoms and signs of osteitis deformans, the results of special vascular studies, and the pattern of the arteriograms probably are dependent largely on the degree of bony involvement produced by this disease.—*William C. MacCarty, Jr., M.D.*

Wassner, U. J. Ein weiterer Fall einer Akro-Osteolyse—zugleich ein Beitrag zu ihrer Differentialdiagnose. (Another case of acro-osteolysis—with a discussion of its differential diagnosis.) *Fortschr. a. d. Geb. d. Röntgenstrahlen ver. m. Röntgenpraxis*, Feb., 1954, *80*, 186–191.

Acro-osteolysis is manifested roentgenologically by marked decalcification or complete disappearance of osseous details of the distal phalanges of the hands and feet symmetrically, in the lateral end of the clavicles, and in the alveolar processes. The remainder of the skeleton apppears normal.

Various opinions exist regarding the etiology of this condition. Harnasch believes the cause to be decreased function of the eosinophil cells of the pituitary gland; Kleinsorge considers his one case to be a variant of osteomalacia; Jesserer opposes both above views, and in his patients could demonstrate one primary and one secondary hyperparathyroidism.

The case report is presented of an individual who had resection of the stomach for ulcer forty-three years ago and has remained thin since then. Two years ago, the teeth began to fall out in rapid order. His strength has been declining of recent years and he has had pains in both thighs. Five years after these symptoms appeared, he noted small reddish depressions on the nails of his fingers and toes. Soon, the nails became soft and loose without producing any pains. The nails then began to shrink to small remnants at which time he noted slight pains in the finger tips. Sensation of feeling of the fingers has remained good. On examination, the patient was weak and showed poor musculature. The tips of the fingers and toes were clubbed and soft with the finger nails short and frayed. Roentgenologically, there was complete recession of the alveolar process of the upper and lower jaws, and the lateral end of both clavicles was absorbed almost completely. There was almost complete osteolysis of the terminal phalanges of the first and second digits and partial osteolysis of the fifth digit of the right hand; on the left hand, all the terminal phalanges were almost completely absorbed. Somewhat similar findings were noted in the terminal phalanges of both feet.

In differential diagnosis, the following conditions were considered: syringomyelia, tabes dorsalis, Raynaud's disease, scleroderma, etc. Blood chemistry was normal except for the residual nitrogen which was elevated to 48 mg. per cent. No evidence of hyperparathyroidism or osteomalacia could be

found. Barium meal examination showed very rapid emptying of the stomach so that barium was noted in the first portion of the ileum within ten minutes. The transit was normal in the remainder of the intestinal tract.

The author concludes that in this particular case the cause of the acro-osteolysis could be explained as follows: Subsequent to resection of the stomach, the patient was in a chronic state of hunger, with acidosis and secondary disturbance of calcium and phosphorus resorption. The bone changes are to be considered as an intestinal osteoporosis.

Treatment was directed as for a total gastrectomy, with high calcium, phosphorus, and vitamin intake. The patient improved considerably within six weeks. The residual nitrogen decreased to 36 mg. per cent. At the end of three months, the patient became strong enough to work again for the first time in five years. —*Samuel Richman, M.D.*

Starke, O. Hustenfrakturen (Ermüdungsbrüche) der Rippen. (Cough fractures [fatigue breaks] of the ribs.) *Fortschr. a. d. Geb. d. Röntgenstrahlen ver. m. Röntgenpraxis*, Feb., 1954, *80*, 191–197.

The author believes that the occurrence of rib fractures as a result of coughing is not so rare a phenomenon as has been accepted to date. The pull on the muscles attached to the ribs as the result of sudden, repeated, strong and jolting contractions (as in coughing and sneezing) has been explained as the cause of cough fractures of the ribs. In addition, considerable weight should be attached to the stress and bending of the thoracic cage, particularly when the fractures occur at the sites of the greatest curvature of the ribs. The ribs on the right side appear to be more rarely involved by spontaneous fractures.

Within the past half year the author has seen 15 patients with diseases involving the lungs and in whom cough fractures occurred. The lung diseases were bronchial asthma (8 cases), chronic emphysema and bronchitis (3 cases), acute severe bronchitis with bronchial pneumonia (3 cases), and early tuberculosis of the lungs (1 case). In all these patients there was a strong, disturbing cough of some duration. No trauma of any nature occurred in any of these patients. The age of the patients varied from thirty-five to seventy-four years. In no case was there organic bone disease or any metabolic disturbance.

Roentgenologically, there was a wavy line of decreased density, which could be distinguished easily from the sharply outlined straight line of a traumatic fracture. The point of separation showed the width of the area of bone absorption, and, strictly speaking, demonstrated as yet no true fracture. Later, periosteal new bone formation was noted at the fracture site. The line of radiolucency may be so wide that it simulates the appearance of a pseudarthrosis.

It has been found that there was only a slight tendency to healing of the cough fractures, with very slow regression of the callus. This is so because continuous coughing prevents immobilization of the ribs. The same rib may be fractured after the first fracture has healed. Eight patients showed fractures of only one rib and in 7, several fractures occurred.

Six of the author's patients noted the occurrence of the fracture by a "crack" or by a sudden sticking pain in the region of the fracture site. In these cases there was usually a perceptible dislocation of the fragments. The tendency to heal was better in those fractures where no dislocation was present. No complications of the fractures were noted, except in 1 case where a hemothorax was believed to have been present.

There is no special treatment for cough fractures. Anticough mixtures are used generously. Strapping of the chest was done, but without any appreciable influence on the healing of the fracture.—*Samuel Richman, M.D.*

Frankel, Charles J. Aspiration biposy of the spine. *J. Bone & Joint Surg.*, Jan., 1954, *36-A*, 69–74.

The author regards aspiration biopsy of the spine as a valuable although not an infallible method of securing a diagnosis in obscure lesions of the spine. However, since small bits of tissue are obtained through a partially blind approach, a negative diagnosis in many cases simply indicates a failure to aspirate pathological tissue and does not necessarily imply an absence of pathology. He suggests that the procedure be used more widely, together with the laboratory, clinical and roentgenographic aids in obscure cases.

All aspiration biopsies are done under roentgenographic control with the patient anesthetized preferably by sodium pentothal. The patient is placed in a prone position. The spinous process of the involved vertebra is identified and marked. A spot 6.5 cm. from the midline is selected and likewise marked. The skin is punctured with a thin tenotome and a long 1 mm. stylet is inserted at an angle of exactly 35 degrees toward the midline. The stylet has a mark at the 7 cm. level so that danger of penetration beyond that area is eliminated and with it the danger of striking the renal pedicles is diminished. In lumbothoracic aspirations, it must be remembered that the aorta lies anteriorly, usually about 10 cm. from the skin, and to the left of the vertebra, while the renal pedicles are usually about 8 cm. from the skin and could be injured by a needle placed at an angle of more than 35 degrees.

When the stylet is felt to strike bone, it is usually imbedded slightly. Anteroposterior and lateral roentgenograms are made in the operating room and developed within a period of one minute. If the stylet is found to be favorably placed, a second, larger bore needle with a saw-tooth edge is passed over the

stylet and the latter is withdrawn. A 5 cc. syringe is attached to the needle and the needle is turned into the bone tissue while a strong suction pressure is maintained by the syringe. If fluid is aspirated, the syringe is disengaged, and the material is saved for smear and culture. The needle may be withdrawn slightly, while contact with the bone is still maintained and moved to another spot in the vertebra for the aspiration of more bony material. After the needle has been withdrawn, a large core of bony material may usually be released by forcing the stylet through the needle.

Thirty-four cases in which aspiration biopsy was used are included in the series reported. A definite diagnosis was established in 20 cases. The tumors included myosarcoma, Ewing's tumor, chordoma, metastatic carcinoma, solitary myeloma, multiple myeloma and angioendothelioma.—*Ralph S. Bromer, M.D.*

Runge, Carl F. Roentgenographic examination of the lumbosacral spine in routine pre-employment examinations. *J. Bone & Joint Surg.*, Jan., 1954, *36-A*, 75–84.

According to the author, the advantages of a roentgenographic survey of the lumbosacral spine include: (1) the reduction of losses from a compensation point of view by the refusing of employment to persons to whom a company has no obligation by virtue of previous employment and who have spine defects which represent a definite risk for future claims. It is also an advantage, in the case of those persons for whom an obligation to employ exists, to have a record of pre-existing spine defects in case of future injury; (2) in the case of persons who are employed with spine defects, the pre-employment examination allows the intelligent placing of them in positions which involve less risk or otherwise limit their activity; (3) from the individual's point of view, it has been possible to advise those who were refused employment because of spine defects that it would be safer for them to seek employment of a less arduous nature.

In the second year of the operation of this survey, the policy was adopted of the rejection of all persons for employment who had spine defects and who were without seniority gained by previous employment when their spine defects fell in the following categories:

1. Acquired defects such as fractures, disc abnormalties, presence of pantopaque in the neural canal and previous spine fusions;
2. Osteoarthritic (hypertrophic) changes of any degree;
3. All defects involving the lumbosacral joint including such conditions as all varieties of transitional vertebrae and spondylolisthesis;
4. Abnormal curvatures of marked degree;
5. Miscellaneous defects, such as tumors.

The findings in 4,654 roentgen examinations of the lumbosacral spine were divided according to age, and the incidences of the various abnormalities were correlated with age as shown in tables of the paper. Defects which the author felt to be of actual or potential clinical significance and which were demonstrable in roentgenograms were found in 1,174 applicants, or 25.44 per cent of the persons examined. Approximately 10 per cent of the applicants were rejected for employment because of spine defects. It was both necessary and desirable to accept for employment a certain number of persons with defects of the spine because of seniority established by prior employment in the plant. However, the author feels that as time goes on, the tendency will be to adopt more rigid standards for acceptance. He also, believes that after a period of years, it should be possible to report on the incidence of subsequent injuries and resultant claims in individuals with and without pre-existing structural defects of various types.—*Ralph S. Bromer, M.D.*

Giannestras, Nicholas. Legg-Perthes disease in twins. *J. Bone & Joint Surg.*, Jan., 1954, *36-A*, 149–152.

In this paper, the occurrence of Legg-Perthes disease in identical twins is reported. There was also concomitant presence of coxa plana in a younger sister. A roentgenographic study of the entire family including the father, the mother and 5 other siblings, revealed no involvement of the epiphyses. Careful questioning of the parents about the presence of any hip disease or instability in the aunts, uncles, grandparents and great-grandparents of the children did not elicit any additional evidence of coxa plana.

A short review of the literature is included. Roentgenograms of the hips of the children and also one of the feet of the younger sister, which showed irregular ossification of the tarsal navicular in each foot, are reproduced.—*Ralph S. Bromer, M.D.*

Mendelsohn, Howard A., and Alban, Seymour L. Complications in replacement arthroplasty of the hip. *J. Bone & Joint Surg.*, Jan., 1954, *36-A*, 30–36.

The authors state that the operation known as replacement arthroplasty of the hip is enjoying a popularity rarely accorded a surgical procedure which has not passed the test of time. Despite allegations of the contrary, substitution of a portion of the hip joint by a prosthetic appliance is a surgical procedure of some magnitude, and is inevitably attended by a variety of complications. A total of fifty-three complications occurred in 23 patients.

There were 6 deaths. Five postoperative dislocations, all of the anterosuperior type, were observed in the series. Since the compilation of their statistical study, the authors had an additional case of this type. They regard the following conditions as signif-

icant predisposing factors to postoperative dislocations: insufficient length of the femoral neck; inadequate depth of the acetabular cavity; excessive valgus placement of the prosthesis. Superior subluxation was noted in 10 cases. Nine patients showed roentgenographic evidence of calcification in the soft tissues adjacent to the hip joint. Three patients complained of disabling pain at the site of protrusion of the stem from the lateral cortex of the femur. Three patients had stem protrusion and, of these, 2 had fractures of the femur. Varus deformity occurred postoperatively in 2 patients. Three had fractures of the prosthesis. Thirteen patients had varying degrees of persistent pain three to sixteen months after operation.

Although their study is not an end-result evaluation, the authors feel justified in recommending that surgeons have a critical awareness of the many hazards involved in the operation. Prostheses of the Judet type, Eicher variety and Jaenichen-Collison type were used. Roentgenographic reproductions of some of the complications are included in the paper. —*Ralph S. Bromer, M.D.*

Sonnenschein, Arnold. Roentgenographic visualization of the patella. *J. Bone & Joint Surg.*, Jan., 1954, *36-A*, 109–112.

To visualize the patella alone, the author recommends a technique which permits a broad, isolated roentgenographic reproduction of the knee cap. The principle of the technique depends upon the fact that, with complete relaxation of the quadriceps, the patella can be displaced from its intercondylar position either medially or laterally to almost half its width, This displacement is not equal, since it depends upon the variations in flattening of the anterior surfaces of the condyles. Physiologically, the lateral femoral condyle is less developed and the patella can therefore be displaced to a greater extent laterally. Before the roentgenological exposure is made, the horizontal mobility of the patella should be tested and the side of the greatest excursion should be selected. Nevertheless, hardly half of the patella is exposed. To visualize more of the patella, the roentgen tube is placed on the subluxated side at a distance of 70 cm. and an angle of 40 degrees to the patella. The leg is rotated 10 degrees laterally if the patella is dislocated laterally and 10 degrees medially if the patella is dislocated medially.

The patient lies in the prone position and the involved limb is fixed by sand bags placed around the ankle in the previously determined position of either internal or external rotation. The femur is held fast and the patella is forced outward or inward as much as is possible. Care must be exercised that the patient is comfortable and that the quadriceps is relaxed, since only thus can the patella be displaced from its gliding bed. To hold the patella in this maximum lateral displacement and to avoid the use of shadow-casting aids, a wooden spatula as wide as a tongue depressor and twice as long is used. The roentgen tube is placed on the side of the patellar displacement, which is usually laterally, so that its central beam strikes the patella at an angle of 40 degrees. It is seldom possible to displace the patella sufficiently so that it can be visualized in its entirety without femoral overlay. In most cases one-third or one-fourth of the patella is covered by the femoral condyle. This portion of the patella can nevertheless be visualized in such a way that the contours and internal structure can be accurately scanned and all structural details can be clearly determined.

This visualization of the patella is useful in cases of congenital anomaly, in degenerative changes and it is indicated for both diagnostic and therapeutic purposes in destructive processes of an inflammatory nature.—*Ralph S. Bromer, M.D.*

Kelly, J. P. Fractures complicating electro-convulsive therapy and chronic epilepsy. *J. Bone & Joint Surg.*, Feb., 1954, *36-B*, 70–79.

Opinion varies considerably about the risk of fractured limbs and spines in the use of electro-convulsive therapy in psychiatric practice. Accidental electric shocks have caused severe injuries to spine and limbs, but with electro-convulsive therapy the passage of the current is briefer, the voltage is lower, and the amperage is less. Nevertheless the current is sufficient to produce unconsciousness and epileptiform seizures and in some cases contractions so great as to cause fractures of the spine or other bones.

A study of 2,200 patients receiving electro-convulsive therapy showed that fifty-three sustained fractures or dislocations, an incidence of 2.4 per cent. Of the 53 injuries, twenty-one occurred in the spine, fifteen in the neck of the femur, fifteen in the upper end of the humerus, one in the coracoid process; one dislocated jaw required anesthesia for its reduction (other cases of transient dislocation of the jaw were excluded). No late changes were found in the spines of patients examined two years or more after treatment. A neutral position of the spine during the convulsion, is believed to diminish the risk of fracture. Fracture of the neck of the femur is a serious injury in these patients. In one case the injury was bilateral. The fractures of the spine occurred throughout the thoracic area with the exception of one case in the lumbar region in which fractures of the second and fourth lumbar were combined with one of the tenth thoracic. Most fractures occurred during convulsions other than the first. This might suggest that damage leading to softening is caused by the first or early convulsions.

Fractures of the upper extremity occur almost exclusively around the shoulder joint. The type of fracture varied from a simple avulsion of the greater tuberosity to a comminuted fracture-dislocation of

the upper end of the humerus. No case of dislocation of the humeral head without fracture was observed in the series. In two cases the dislocation was posterior. Two of the cases showed associated fracture of the scapula, one of the axillary border near the lower angle and the other of the anterior margin of the glenoid cavity.

Fatal complications are rare and in the series of 20,000 cases there was only one death. It is generally agreed that the incidence of fracture has been reduced since electro-convulsive therapy has replaced cardizol. The wedging of the vertebrae in the spinal fractures suggests that it might be brought about by the sudden flexion spasm which sometimes occurs at the beginning of the fit. The fact that posterior dislocation of the humerus occurred on two occasions also favors the view that the injury occurred at the flexion stage of the convulsion. The second type of fractured vertebra seen was the "disk repercussion" fracture in which the disk is forced into the vertebral body by fracture of its superior surface. It is suggested that this is due to severe longitudinal compression of the spine and the most likely time for this to occur is when the patient is in opisthotonos. Hence a neutral position of the spine, neither flexed nor hyperextended, during the convulsion is desirable to diminish the risk of fracture, and the intensity of the convulsion should be lessened either by the administration of a relaxant such as a curare preparation or "by inducing slowly developing seizures by means of the lowest possible current intensity" (quoted from Kalinsky and Hock 1952).

Fifty-three patients with chronic epilepsy with psychosis were examined. Four cases of fractured spine were discovered. The site of fracture differed from that of fracture complicating electro-convulsive therapy. No fracture of the thoracic spine was found above T. 7. There was one fracture of the lumbar spine alone. In half of the cases one vertebra was involved; in the other half, two vertebrae were affected. The type of fracture was similar to that complicating electro-convulsive therapy, the body of the vertebra alone being involved. The difference in the site of fracture in the two groups might be explained by the fact that some epileptics are standing when the fit occurs, whereas patients having electro-convulsive therapy are lying down and the fit is controlled. When the patient is standing the knees are extended and the pelvis is fixed by the strong hamstring muscles. Forced flexion of the spine at this stage puts considerable stress on the lumbo-sacral region and lower half of the spine. Hence it is suggested that the site of fracture is different from that complicating electro-convulsive therapy because the fulcrum of movement is lowered from the upper thoracic level.—*Ralph S. Bromer, M.D.*

Fraser, F. Clarke, and Scriver, Jessie Boyd. A hereditary factor in chondrodystrophia calcificans congenita. *New England J. Med.*, Feb. 18, 1954, *250*, 272–277.

A report of 2 cases of chondrodystrophia calcificans congenita occurring in siblings is presented. The disease is a rare congenital condition which can be diagnosed roentgenographically. The typical case reveals multiple punctate calcifications in the epiphyses of long bones and in the cartilaginous tarsal and carpal bones. The diaphysis of the long bones may be short or thick with splayed ends. In patients who survive infancy, the calcific foci eventually disappear.

There is usually associated one or more of the following defects: shortening of the limbs, flexion contractures, enlarged head, congenital cataracts, mental deficiency, heart anomalies, or skin lesions.

In about one-half of the reported cases, death has occurred within the first year of life.

The authors present a genetic analysis of the 39 reported cases on the hypothesis that the disease is hereditary. They have found that the incidence of parental consanguinity is higher in the families of the reported cases. Their conclusion is that the disease shows simple recessive mendelian inheritance. Therefore, the probability of any subsequent child having the disease in a family in which one child is affected, is about one chance in four.—*D. V. Campbell, M.D.*

Gold, Aaron M., and Oppenheim, Abraham. Deep intermuscular lipoma of an extremity. *J. Bone & Joint Surg.*, Jan., 1954, *36-A*, 146–148.

The case of a deep intermuscular lipoma of the forearm, reported in this paper, is presented by the authors because of the symptoms produced by the tumor, the roentgenographic appearance of the involved site, and the complete relief following excision.

Examination of the affected forearm demonstrated palpable grating along the posterolateral aspect of the upper part of the forearm and of the elbow when these parts were moved. There was hypoesthesia of the skin over the pathways of the ulnar nerve, associated with scattered areas of sensory median nerve involvement. The patient complained of a "grating" sensation "in back of the elbow" on the motion of the joint. Use of the extremity aggravated the pain.

On roentgen examination a sharply demarcated, multilocular, air-bubble-like area of radiolucency was readily discernible in the flexor compartment of the proximal third of the forearm in relation to the radius. Later roentgenograms indicated an increase in size of the radiolucent area.

A tumor was removed at operation. It was well encapsulated and was shelled out easily. Microscopic examination showed the mass to be a simple lipoma. Follow-up examinations showed no recurrence of the mass nor was there any recurrence of the symptoms. —*Ralph S. Bromer, M.D.*

Blood and Lymph System

Ecker, Arthur. Emotional stress before strokes: a preliminary report of 20 cases. *Ann. Int. Med.*, Jan., 1954, *40*, 49–56.

Twenty patients with cerebral vascular disorders are presented. Most were under the age of fifty years. In 13 cases there was non-traumatic intracranial hemorrhage, and 8 cases had hemiparesis that was clearly organic; 1 patient had both subarachnoid hemorrhage and hemiparesis. In 13 of these cases there were long-standing personality difficulties, and in 15 a special emotional stress immediately preceded the stroke; in 8 cases both factors were present.

Angiograms technically suitable for study of spasm of the cerebral arteries were available in 15 cases. All of these showed strong evidence of arterial contractions. In other material 90 per cent of the patients with cerebral stroke have shown such spasm. On the contrary, in the general run of patients requiring angiography, such as brain tumor suspects, spasm was demonstrable in only 10 per cent of the cases. Therefore, it seems that in the patients with stroke at least the threshold for the production of spasm is lower than the average. This spastic tendency may be one of the bodily expressions of the emotional disturbance. The high incidence of major emotional problems preceding cerebral strokes warrants further attention.—*Paul R. Dirkse, M.D.*

Glenn, Frank, Harrison, Charles S., and Steinberg, Israel. Pulmonary arteriovenous fistula occurring in siblings; report of two cases. *Ann. Surg.*, Dec., 1953, *138*, 886–891.

In 1939 the first pre-mortem diagnosis of pulmonary arteriovenous fistula was reported. In recent years mass chest filming had led to the diagnosis of many such cases. This is an important condition which may be completely or relatively asymptomatic until serious complications occur. Two sisters are reported with convincing angiocardiographic findings. In one, a typist of nineteen, the fistula was in the anterior segment of the left upper lobe. The other sister, a housewife of twenty-five, had a density in the dorsal apical segment for at least eight years prior to resection.

If these lesions had been allowed to advance without operative resection the classical triad of cyanosis, pulmonary osteoarthropathy and secondary polycythemia might have resulted. If a bruit occurs it is likely to be systolic; or, if over a large fistula, to and fro. Some patients show associated telangiectasis of skin and mucous membranes. More than one fistula may be present and angiocardiographic survey is in order.

Surgery is advocated even if the lesion is asymptomatic. In addition to cardiovascular and respiratory complications, associated brain abscesses and fatal hemoptysis have been reported in cases not treated by resection.—*John W. Turner, M.D.*

deWolfe, Victor G., LeFevre, Fay A., Humphries, Alfred W., Shaw, Malin B., and Phalen, George S. Intermittent claudication of the hip and the syndrome of chronic aorto-iliac thrombosis. *Circulation*, Jan., 1954, *9*, 1–16.

The commonest symptom of occlusive arterial disease of the lower extremities is intermittent claudication. When present, this symptom is pathognomonic of arterial insufficiency. While intermittent claudication occurs most frequently in the calf, it can occur in the thigh or foot. What has not been generally appreciated is that it can also occur in areas proximal to the thigh, such as the hip, buttock, and low back. Thus, the diagnosis is often missed and confused with orthopedic disturbances. It need not be a pain but it may manifest itself as a cramp, a tightness, a weakness, or fatigue.

Forty-seven patients with intermittent claudication of the hip were studied at the Cleveland Clinic and the results are presented in detail. Aortography was performed in 30 cases and proved invaluable as a diagnostic aid. Occlusion of the abdominal aorta was demonstrated in 7 cases; of one common iliac artery in 11 cases; of both common iliac arteries in 4 cases; of one external iliac artery in 2 cases and of one common iliac artery in 1 case. One patient had diffuse disease of the aorta without an occlusion; one aortogram was normal, and the remaining three were unsatisfactory.

Clinically, it was of interest that while 97.8 per cent of the patients had symptoms at a high level (hips, thighs, low back, or abdomen), only 55.3 per cent had calf symptoms. None had symptoms in the calf alone. The nutrition of the legs and feet was almost always good and it appeared that the higher occlusions were more apt to be associated with an efficient and adequate collateral circulation which had two principal routes. One was more lateral, the blood passing from the lumbar arteries to the "cruciate circulation" of the hip, the medial and lateral circumflex arteries and then to the femoral arteries. Of lesser importance and frequency was an anastomosis between the lower lumbar and/or upper sacral arteries, through the obturator artery to the circumflex femorals and then to the femoral arteries. Plain roentgenograms showed calcification of the aorta in 19 cases; no instances of the Monkeberg type were seen.

Insidious thrombosis of the terminal aorta and iliac vessels is often mistaken for several other conditions causing pain about the hip. A large number of these cases had previously been diagnosed as ruptured intervertebral disks, osteoarthritis of the lumbosacral spine or hip, or bursitis of the hip. Any malformation or disease involving the structures

about the hip may be accompanied by intermittent pain in this area.

The treatment of this condition is not completely satisfactory. Surgical measures such as excision and replacement grafts, endarterectomy, and sympathectomy have not yet proved encouraging enough to supplant conservative measures. Smoking and physical excess are forbidden, the head of the bed is elevated, proper care of the feet, and reflex heat to the abdomen for twenty minutes twice a day are among the measures advocated. The disease did not seem to be chronically progressive during the five year period the patients were under observation.

Six representative case histories are presented and the literature reviewed.—*S. A. Kaufman, M.D.*

General

Greenberger, Edw. D. Radiology in a small community. *Radiology*, Jan., 1954, *62*, 88-90.

The author draws on his own experience to illustrate the favorable opportunities for stimulating and profitable work in radiology in a small town. He serves a town in Oklahoma having a population of 20,000 persons and a medical society of 23 physicans. Surrounding counties supplement these figures considerably. His work is carried out in two 60-bed hospitals, a clinic, and in his own office. In a recent twelve month period 5,340 examinations were done. One-fifth of these were gastrointestinal. During the same period he treated 115 skin cancers, 37 lip and mouth cancers, 12 breast carcinomas, 16 cervix carcinomas and 39 other malignancies of widely variant nature. He cites the reports of other radiologists in small towns, showing that his experiences are not unusual, and concludes that the practice of radiology in a small community is satisfying and remunerative—*William A. Goodrich, Jr., M.D.*

Mahrer, Peter R., Evans, John A., and Steinberg, Israel. Scleroderma: relation of pulmonary changes to esophageal disease. *Ann. Int. Med.*, Jan., 1954, *40*, 92–110.

Scleroderma is a systemic disease involving the collagenous tissues. The skin, gastrointestinal tract, and the cardiovascular, musculoskeletal, genitourinary and pulmonary systems may be involved. Dysphagia is a common complaint when the esophagus is affected. The lung changes in previously reported cases are reviewed and 16 cases added with attention to the relationship of the pulmonary changes and dysphagia.

The roentgen findings consist of mottling of the lung parenchyma indistinguishable from a pulmonary fibrosis and usually occurring at the bases. Occasionally a "honeycomb appearance" or cysts of various sizes are seen at the bases. The changes in esophageal involvement are not constant but follow a recognizable pattern. The transit of barium through the esophagus is delayed. Peristalsis is decreased or absent. The proximal two-thirds of the esophagus is often dilated and the cardiac end frequently narrowed and rigid. Barium adheres unevenly to the walls of the esophagus. Dilatation is less marked than with cardiospasm. The cardiac end, though narrowed, is patulous and allows barium to pass into the stomach, unlike cardiospasm.

An attempt was made to determine whether the pulmonary changes in scleroderma are secondary to aspiration. If aspiration were the chief cause of pulmonary changes, esophageal lesions would be present in all cases with pulmonary findings. This was not true in the cases of this group or in those previously reported in the literature. Hence, while aspiration pneumonia and subsequent pulmonary fibrosis may occur, they are not the primary factors in the pulmonary disease.—*Paul R. Dirkse, M.D.*

Singleton, Edward B., and Holt, John F. Myositis ossificans progressiva. *Radiology*, Jan., 1954, *62*, 47–54.

The etiology and genetic relationship and pathological process of myositis ossificans progressiva are discussed. A case is presented in which roentgenograms were made at the onset and during the course of disease showing graphically the progressive nature of the disease. The patient's disability changed little in spite of the extensive roentgenological manifestations. This suggests that the replacement of the degenerating connective tissue in the fascia, tendon, and intermuscular septa by extensive fibrosis accounts for the immobility rather than the ossification which occurs later in the course of the disease.

The question is raised whether adrenocorticotrophic hormone or cortisone may be beneficial in the early stages of the process. The authors' experience confirmed other reports that surgical intervention is not beneficial. The article is well illustrated with figures.—*Everett E. Seedorf, M.D.*

Jarvis, J. Luther, Jenkins, Dalton, Sosman, Merrill C., and Thorn, George W. Roentgenologic observations in Addison's disease; a review of 120 cases. *Radiology*, Jan., 1954, *62*, 16–29.

This study is based on the roentgen examinations of 120 patients with Addison's disease. The patients accepted for study met the diagnostic requirements of history, physical examination, laboratory findings and special tests which are described.

Roentgen examination of the chest, skull and abdomen was performed in the majority of patients. Adrenal calcification was present in 23 per cent of 106 patients. It is concluded that adrenal calcification is *not* pathognomonic of adrenal cortical insufficiency, but constitutes presumptive evidence for the disease and indicates the need for thorough diagnostic study. Of 24 patients with adrenal calcification, 46 per cent

showed no evidence of pulmonary tuberculosis, 25 per cent showed inactive tuberculosis, while 29 per cent exhibited active tuberculosis. This seems significant in view of the recognized importance of tuberculosis in the pathogenesis of Addison's disease. The authors believe this importance is declining.

In the authors' experience, no patient with untreated and uncomplicated Addison's disease has been encountered in whom cardiac enlargement was demonstrable. The features of hypotension and low pulse pressure were observed. Following the administration of adrenal cortical hormones, cardiac dimensions increase and may exceed normal limits. Therefore, serial roentgenologic measurements of heart size may be useful in the regulation of maintenance hormone treatment.

The significance of other positive findings such as reduction in kidney size, splenomegaly, and calcification, as well as ossification in the external ear are discussed.

The value of periodic roentgenologic study of patients with Addison's disease is emphasized.—*Everett E. Seedorf, M.D.*

RADIATION THERAPY

Lehmann, C. F., and Pipkin, J. L. Radium in malignant cutaneous disease. *J.A.M.A.*, Jan. 2, 1954, *154*, 4–8.

Two techniques for interstitial radium in skin cancer are described: (a) short-time, high-intensity technique, and (b) long-time, low-intensity technique. High-intensity radium needles (10 mg. radium, 19 mm. actual length, 12 mm. active length, 0.3 mm. platinum filtration) are arranged in a triangle about the border of small lesions, or arranged in parallel fashion as planar implants. Beta (9 per cent) and gamma (91 per cent) rays are thus utilized, shortening treatment time to two and one-half to three hours. The method is therefore suitable for office procedure. This technique is reserved for lesions less than 1 cm. in diameter and under 0.5 cm. in depth.

Larger areas, and certain resistant smaller lesions (*i.e.*, side and back of neck, dorsum of the hand), require a long-time, low-intensity approach. These needles, of 0.5 mm. platinum filtration, contain 0.66 mg. radium per cm., 15 mm. active length, 27.7 mm. total length. Planar implants are most commonly used, the needles being sutured in place with fine wire for five to nine days (5,000 to 7,000 gamma roentgens). Previous infiltration with novocaine produces local anesthesia and may help delimit the lesion by the characteristic "feel" during the injection. The raised wheal produced also allows easy horizontal introduction of the radium needles into an otherwise flat surface.

The cure rate is estimated to have risen from 80 to 95 per cent in 1935 to 95 to 97 per cent in 1945. This is believed due to earlier institution of treatment rather than improvement in technique.—*J. Maurice Swain, M.D.*

Andrews, George C., Domonkos, Anthony N., and Hurlbut, Wilbur B. Roentgen irradiation in the treatment of epithelioma. *J.A.M.A.*, Jan. 2, 1954, *154*, 21–22.

One thousand cases of epithelioma of the skin were surveyed, chosen at random from the files of the Department of Dermatology of the Columbia-Presbyterian Medical Center. Over half of the patients were treated initially by irradiation. Of 410 cases proved by biopsy, 81 per cent were basal cell epitheliomas, 14 per cent were squamous cell, and 5 per cent were basosquamous or other types of epitheliomas. The majority of these patients were over sixty years of age. Nearly one-quarter of the lesions were located on the nose, 4.6 per cent were at the inner canthus of the eye.

One case of radionecrosis was encountered (epithelioma of the ear treated by an obsolete technique using radium).

Only 220 patients were followed for five years or more, among whom the cure rate was 93 per cent following irradiation alone, and 96 per cent from surgical excision alone. The recurrence rate was 3.5 per cent for the total group.—*J. Maurice Swain, M.D.*

Schinz, H. R. Zwei Jahre Forschung und Erfahrung mit dem 31-MeV-Betatron am Kantonsspital in Zürich. (Two years of research and experience with the 31 mev. betatron at the Cantonal Hospital in Zürich.) *Fortschr. a. d. Geb. d. Röntgenstrahlen ver. m. Röntgenpraxis.* Jan., 1954, *80*, 1–28.

The installation (Brown Boveri)was employed primarily for therapeutic purposes, yet nondestructive testing, as well as nuclear and radiobiologic research also received attention. The use of electron beam is not mentioned, though an optional electron peeler is available with this model.

The maximal depth dose in water is obtained at 5 cm., with 17–20 per cent entrance dose, and 80 per cent at 16 cm. Obviously, skin reaction will be minimized, but healthy tissue beyond the tumor may receive high amounts of radiation. Half-value layers for 31 mev. are: water 330 mm., plexiglass 280 mm., copper 30 mm., and lead 15 mm.

The betatron beam is sharply defined. With reduced scattering, it gives proportionately less systemic reaction. By comparison, its integral dose is smaller than with any form of conventional irradiation, be it with crossfire technique or with rotational, pendular or convergent beam.

Even the margins of the 31 mev. roentgen beam are more homogeneous. The absorbed energy, calculated per gram of substance for 10 mev. was: muscle 100 per cent, bone 102.2 per cent, water 101.4

per cent, average tissue 99.9 per cent. These peculiar absorption coefficients are well demonstrated by the fact that bones cannot be outlined on a hand roentgenographed with 31 mev.

The betatron radiation is intermittent, giving 50 peaks per second: the duration of each of these roentgen bursts is 10^{-6} sec., the energy 10 mr, the intensity 30 r/min., the time of irradiation compared to the interval 1:2,000. It causes pair formation (besides Compton effect), its ion concentration is higher than, and geometrically different from, conventional energies, and the secondary electrons reach as far as 50 mm. in water, compared to 0.1 mm. at 200 kv.

The 31 mev. roentgen beam contains also primary electrons and neutrons, originating from the anticathode, from the filter, and from the collimating lead.

In the axis of the beam, measurements revealed 10^4 neutrons (with energies of 1 mev. and higher) per cm.^{2}/sec. The maximal neutron background in the control room amounted to 20 per cent of the tolerance dose.

A chamber filled with heavy hydrogen at 12 atmospheres was used for the measurement of the angular distribution of protons, resulting from the disintegration of deuterons in protons and neutrons. A prismatic volume of gas is irradiated through a collimated 6 by 12 mm. beam. The nuclear energies of the protons and neutrons may be calculated from the measured angular (every 10°) distribution of protons. The betatron spectrum may also be determined by translating the proton energies in quanta.

Radioactive isotopes were experimentally produced (I^{125}, P^{32}), though of energies far below useful levels. It is worth mentioning that radioactive isotopes (mainly O^{15}, C^{11}, N^{13}, P^{30}, K^{38}, K^{43}) are generated during betatron irradiation of the tissues. However, after 700 r, the total additional dose is in the vicinity of 0.02 rep, *i.e.*, insignificant.

Tables are given for comparison between entrance, tumor, and exit doses for 200 kv., 800 kv. and 31 mev., stressing the advantages of the latter. In the theoretical case of esophageal carcinoma at 12 cm. for 25 cm. chest thickness, a 6,000 r tumor dose is given through one 8 by 14 cm. port: with 200 kv. the entrance dose would reach 25,000 r, the exit dose 600 r; with 800 kv., the figures change to 13,000 and 3,000; for the betatron they are 1,100 and 3,600.

Several cases are briefly reported from a total of 65, including an esophageal carcinoma which received 12,000 r in fifty days, a bronchogenic carcinoma treated with 300 r daily (total 11,400 r), cranial metastases irradiated with 240–300 r through three ports (total 10,140 r), etc. No conclusions are drawn, because far advanced or even terminal cases were selected for this series.

It is stated that as of today the betatron has a definite place in radiation therapy. Tentatively outlined indications include (1) deep seated tumors, (2) wherever bones or cartilage are interposed in the beam, (3) whenever skin must be preserved (such as preoperatively), in (4) in recurrent or residual tumor after conventional therapy with serious skin and/or systemic reaction, (5) in single port technique with or without bolus, and (6) in deep seated distant metastases after the primary tumor has been cured. —*E. R. N. Grigg, M.D.*

Martin, Charles L. Treatment of cancer of the tongue and its cervical metastases with irradiation. *South. M. J.*, Jan., 1954, *47*, 1–9.

The author points out that since cancer of the tongue is one of the most common malignant lesions in the oral cavity and since it produces more deaths than any other malignant tumor encountered in the head and neck, every effort should be made to improve the method of treatment. The paramount importance of early diagnosis is stressed.

The methods of treatment are discussed as carried out in our foremost clinics, attention being paid to the very radical surgical procedure of the removal (en bloc) of a portion of the tongue and floor of the mouth and other similar procedures. A table is included showing that in a total of 2,729 cases treated the percentage of five year cures was 20.1.

It is stated that more than half of the patients with cancer of the tongue have cervical lymph node metastases. Table II illustrates that block dissection is considered the treatment of choice for this complication in all of the centers listed.

The author then discusses his own clinical material, which consists of 94 patients from 1936 to 1948 with cancer of the tongue. Some were far advanced and some had been treated unsatisfactorily elsewhere, but all received some form of treatment and none were omitted from this series. Biopsies revealed squamous cell carcinoma in all but 4 cases which had far advanced lesions and could not be diagnosed clinically. All 4 are dead and not included in the cured group.

Table III shows that an over-all five year cure rate of 32 per cent was obtained for the entire series of 94 patients, none of whom had radical tongue surgery or a primary block dissection. All were treated with low intensity radium needles, their size and the dose given being described in the article. A complete tabulation of the 30 cured cases is given in Table IV. The palpable cervical lymph nodes were treated with a combined radium needle and roentgen therapy in 56 of the 94 cases and a satisfactory result after five years was observed in 10, or 17.8 per cent, of the entire group. It is pointed out that the enlargement of the lymph nodes completely disappeared in 70 per cent of these patients and death was due to other causes in many of them.

The complications and the secondary surgery used in these complications are also discussed.

This is an excellent article and is well illustrated with beautiful photographs showing various stages of some of the lesions which are discussed.—*Robert D. Moreton, M.D.*

Russell, Marion H. Cancer of the tongue, mouth, and pharynx; sex differences in prognosis following radiotherapy. *Brit. M. J.*, Feb. 20, 1954, *1*, 430–434.

A suspicion that significant sex differences are present in the results of radiation therapy of certain cancers resulted in this analysis by a medical statistician. The material consists of 2,139 cases of cancer of the tongue, mouth, and pharynx treated with radium or deep roentgen therapy at the Christie Hospital and Holt Radium Institute during the years 1932 to 1942 inclusive.

Ten year survival rates were used as end points. The author feels that crude survival rates (*i.e.*, not corrected for probability of death due to intercurrent disease) underevaluate the results of therapy and therefore gives figures for both crude survival and "age-corrected" survival. However, the two parallel each other, although the age-corrected figures give improved results. Other factors investigated were postoperative mortality, primary recurrence rate, and secondary lymph node occurrence before and after treatment of the primary lesion.

In virtually every phase investigated, the female showed a significant superiority over the male including long-term survival, postoperative survival, response to treatment, and resistance to recurrence and extension of the disease. This favorable factor of the female over the male was on the order of from 1.5 to 2:1. This is illustrated in several tables which treat each of the subdivisions of the mouth, tongue, and pharynx separately. The chief exception occurs in cancer of the hypopharynx and postcricoid region, where the results of therapy are so poor that there is no statistically significant difference between the sexes.

The author concludes that in the presentation of results of therapy of malignant disease, failure to state the age and sex distribution may result in fallacious deductions because of the better prognosis in the female and the increased mortality due to intercurrent disease with advancing age.—*Henry J. Klos, M.D.*

Spittler, August W., Batch, Joseph W., and Rutledge, Ben A. Whole body irradiation on the healing of fresh fractures. *A.M.A. Arch. Surg.*, Jan., 1954, *68*, 93–104.

In modern warfare large numbers of the population may be exposed to total body irradiation. There have been very few reports in the literature of the effects of radiation on fracture healing. The purpose of this paper is to report observations of the effect of whole body irradiation on fracture healing in the rat.

Two hundred and fifty rats were exposed to total body irradiation with doses ranging from 300 to 900 r (a dose of 500 r will kill at least 50 per cent of the strain of rats used). Fifty unexposed rats were used as controls. At weekly intervals each animal had a roentgenogram made of the fractured femora and one animal was killed and autopsied.

It was noticed that the irradiated rats had an irregular loss of hair, were unclean and showed loss of vitality. Those rats which received 300 to 400 r of radiation showed a gain in weight. Those receiving 500 r had a gradual weight loss; rats receiving higher amounts had a marked weight loss.

The mortality rate increased proportionately with the dose of radiation. Some of the rats had internal fixation of their fractures and they were able to bear weight after the first week. The fractured femora which were not fixed internally were noted to angulate and exhibited gross impairment of function.

Microscopically it was demonstrated that extensive irradiation resulted in a delay in the healing of the fracture which was greatest during the first three weeks. Two animals which survived the usual fatal dose of roentgen rays began to gain weight after the fourth week.

It is concluded that if rats survive the effects of the trauma of fracture and whole body irradiation, healing of the fracture will be delayed but can be expected to become complete after the effects of the irradiation have been overcome.—*Wallace M. Roy, M.D.*

Fletcher, Gilbert H., Wall, John A., Bloedorn, Fernando G., Shalek, Robert J., and Wootton, Peter. Direct measurements and isodose calculations in radium therapy of carcinoma of the cervix. *Radiology*, Dec., 1953, *61*, 885–902.

The authors discuss their technique of treatment of carcinoma of the cervix. This technique includes direct dosimetric measurements in the bladder and rectum, calculations by a semi three-dimensional reconstruction procedure of the 7,000 gamma roentgen isodose curve in the plane passing through the paracervical triangle, and the estimation of range of doses to pelvic lymph nodes. Each patient's treatment is varied to fit the anatomical situation by using independent and flexible applicators, and changing the loading of the tandem and colpostat. Readings are taken during placement of the radium to aid in the proper positioning of the sources and the packing. An attempt is made during placement to place it as high as possible in the pelvis and to separate as wide as possible the vaginal radium sources. These steps aid in treating the extension of the disease in the pelvic wall.

Records of accurately calculated or measured doses to the bladder and rectum are being kept in order to have some correlation with the incidence and severity of reaction and to evaluate results.

When the distribution of radium sources is not optimal, external irradiation is used to bring the dosage to the prescribed amount.—*Donald N. Dysart, M.D.*

Cocchi, Umberto. Zur Diagnose und Therapie der Wirbelhaemangiome (Zürcher Erfahrungen an Hand von 26 Haemangiomfällen). (The diagnosis and treatment of vertebral hemangioma; experiences in Zurich with 26 cases.) *Strahlentherapie*, 1953, *92*, 368–374.

The basis of this article is a study of 26 patients with 30 hemangiomatous vertebrae, along with a review of the literature.

Vertebral hemangioma occurs most frequently in the lumbar and mid-thoracic region. It appears slightly more often in women than in men and has been observed in practically all age groups—the youngest patient reported was 12½ years of age and the oldest was 76 years of age.

The tumors are usually small and clinically silent. With larger tumors, dull "rheumatic" and "girdle" pains occur. When the tumor breaks into the epidural space, root pain, motor symptoms and even paraplegia appear.

The roentgen pattern is a lattice work of vertical, sclerotic trabeculae, usually without alteration of the vertebral contour or interspace. The changes become visible when one-fourth or more of the vertebral body is involved. Extensive tumors alter the vertebral contour and may produce compression of the body with gibbus formation and narrowing of the interspace (3 out of 30 affected vertebrae showed compression in this series). With vertebral compression, the vertical striate arrangement of trabeculae is lost and enough subperiosteal bleeding may occur to leave a paravertebral soft tissue density similar to that seen in a tuberculous abscess.

Hemangiomatous vertebrae do not commonly show structural weakness; indeed two of the Zurich patients had traumatic fractures of normal vertebrae while their hemangiomatous vertebrae remained intact.

Of 28 vertebrae, 8 showed involvement of the vertebral body only, one of the vertebral arch only, 18 of the vertebral body and arch, and 3 of all parts of the vertebra. Usually only a single vertebra is affected, but 4 of the 26 patients had two vertebrae involved.

In general, the roentgen diagnosis is not difficult. In 2 of the 26 cases, the roentgen diagnosis was incorrect: one was considered a case of sarcoma until a biopsy demonstrated hemangioma; the other was considered hemangioma until autopsy demonstrated metastasis from carcinoma of the urinary bladder. Differential diagnosis includes tuberculous spondylitis, vertebral metastasis, plasmacytoma, osteitis deformans, osseous lymphoblastoma, polyostotic fibrous dysplasia, and generalized hyperostosis with pachydermia.

Radiation therapy was carried out with doses of 150–240 r in air (at 50 cm. f.s.d. and filtered with 1 mm. Cu or a Thoraeus filter) to two or three fields to a total dose of 4,000–6,000 r in air. Improvement occurred from fourteen days to two months after the start of treatment. Patients became symptom-free in a matter of one to seven months.

Seven patients received no therapy: 6 because they were symptomless and 1 because his general condition was too grave. Of the 19 treated patients, 4 had transverse spinal cord changes and were treated surgically and roentgenologically: 2 of these became symptom-free and 2 were unimproved. The remaining 15 patients received fractional radiation therapy only: 9 became symptom-free, 2 were improved and 4 unimproved.

Postirradiation changes in the appearance of the vertebrae were not demonstrable roentgenologically. Improvement could be judged only by disappearance of symptoms. Although increased ossification of treated hemangiomatous vertebrae has been reported, none in this series showed such a change.—*Henry G. Moehring, M.D.*

Meyer, Ovid O. Treatment of Hodgkin's disease and the lymphosarcomas. *J.A.M.A.*, Jan. 9, 1954, *154*, 114–120.

In this presentation, the treatment of Hodgkin's disease, the lymphoid type of lymphosarcoma, follicular lymphoblastoma and reticulum cell sarcoma is reviewed and discussed. Lymphocytic leukemia might also be included since it is known that the same or similar measures are often employed with some success. Hodgkin's disease has been classified by Jackson and Parker under three headings: (a) paragranuloma, (b) granuloma, and (c) Hodgkin's sarcoma. While this classification has some significance from the standpoint of prognosis and therapy, it must be remembered that each patient should be treated individually. It is not unusual to hear of cases that have lived for as long as twenty years after the diagnosis was made.

Irradiation. Roentgen irradiation is still unsurpassed for treatment in most cases of these diseases. Follicular lymphoblastoma is the most sensitive to roentgen therapy. Many schemes of treatment and dosages have been advocated. The author used 200 kv. (0.5 mm. Cu and 1 mm. Al) roentgen rays. The first series of treatments consisted of 150–200 r (air) per field to a total of 1,600–2,000 r; no more than two fields a day were treated. The treatment was given daily or every second or third day, depending on the patient's reaction. Frequent leukocyte counts should be done and transfusions given if the hemoglobin level is 50 per cent of normal or lower. Bone lesions usually require more intensive therapy, often with favorable results. Only rarely is general body exposure used. Therapy is given as needed to effect relief of symptoms and induce clinical remission.

Radium. Radium is now rarely used in the treatment of lymphomatous disease.

Radioactive Substances. Radioactive phosphorus (P^{32}) has had extensive trial in the treatment of Hodgkin's disease, the lymphosarcomas, leukemias,

and polycythemia rubra vera. It is especially effective in polycythemia vera and granulocytic leukemia, and rather disappointing in the treatment of the others. It was felt that other forms of therapy were better than P^{32} and it was not used.

Nitrogen Mustard. Nitrogen mustards (HN_2) are leukotoxic due to the first ionization product, the ethylenimonium derivatives. It must be administered intravenously in dosages of 0.1 mg. per kilogram of body weight in a dilute solution. HN_2 is a valuable drug, particularly in Hodgkin's disease, but less valuable in the lymphosarcomas and leukemias. It is most useful when there is widespread systemic disease or severe systemic intoxication in which radiation therapy might be hazardous or when the patient is no longer responsive to irradiation. There is some evidence that responsiveness to roentgen therapy may be occasionally restored following HN_2. The remissions induced by nitrogen mustard are usually of shorter duration, six to thirteen weeks, than those following roentgen therapy. The margin of safety in the use of HN_2 is narrow and serious toxic effects upon the blood-forming organs are to be guarded against. The maximum depressant effect of the drug is between the tenth and twentieth day, and a second course of therapy should be avoided during this period. The remissions in repeated courses are often shorter than those initially achieved and ultimately there is no response.

Nitrogen Mustard and Irradiation. These two methods have been combined by giving a single large dose (0.3 mg. per kilogram of body weight) of HN_2 and a single dose of irradiation (800 r) to a single local site. The results do not indicate that this procedure is superior to more conventional methods but there is the advantage of a shortened hospitilization.

Triethylene Melamine. This drug is similar in action to nitrogen mustards. It has fewer of the disadvantages of HN_2 and can be given orally. Two patients out of 34 treated with triethylene melamine died of miliary tuberculosis and the possible relationship of this chemical agent to it is commented upon. The author is enthusiastic about the use of the drug in Hodgkin's disease, lymphocytic leukemia, follicular lymphoblastoma, lymphosarcoma, and, to a lesser degree, reticulum cell sarcoma arising in lymph nodes. He feels that in most situations, roentgen therapy is best when there is localized disease, as long as it is effective, but that triethylene melamine is the most suitable therapy we have to date for generalized systemic disease. Life may be prolonged by the production of additional remissions after irradiation is ineffective.

Corticotropin and Cortisone. Steroid hormone administration has not proved very effective in these diseases.

Surgical Treatment. Occasionally, lymphosarcoma and reticulum cell sarcoma, and, rarely, follicular lymphoblastoma, may be localized and allow surgical excision with postoperative roentgen therapy to the affected site. Hodgkin's disease is rarely seen early enough to allow successful excision. Both in Hodgkin's disease and in leukemia, however, splenectomy may be indicated when a complicating hemolytic process arises that is refractory to other forms of therapy.

Miscellaneous Measures. Antiserums (chicken anti-Hodgkin's tissue and antireticulocytotoxic serum) have been tried without impressive success. Colchicine has also been given a trial. General nonspecific measures such as blood transfusions, antibiotics for intercurrent infections, analgesics, and an adequate diet are of great importance. The maintenance of morale is also stressed in these patients.—*S. A. Kaufman, M.D.*

Arnold, A., Bailey, P., Harvey, R. A., Haas, L. L., and Laughlin, J. S. Changes in the central nervous system following irradiation with 23-mev x-rays from the betatron. *Radiology*, Jan., 1954, *62*, 37–46.

The authors present their analysis of the effects of 23 mev. roentgen rays on normal monkey brain and on tumors of the central nervous system of man. Their findings would indicate that the brain of both monkey and man is more radiosensitive than previously supposed and that the radiation damage is largely to the neural rather than the vascular elements, as previously contended. Another finding has been the striking selective destruction of the white matter occurring in these brains months to a year or more after irradiation.

The range of doses employed in this study, 1,500 to 14,000 r of 23 mev. roentgen rays as delivered by the betatron, is approximately equivalent to 900 to 8,400 r of 250 kv. roentgen rays. Single tissue doses above 7,000 r produced a non-selective necrosis of the traversed brain. In the dose range of 5,000 to 7,000 r an acute response consisting of inflammatory cell infiltration, edema, myelin damage, hemorrhage and small localized necrosis, was followed by gradual recovery. Four months or more after recovery, a delayed nonspecific radionecrosis occurred. Doses between 3,000 and 5,000 r produced the same, though less severe, cycle of events with the delayed radionecrosis being largely selective for the white matter.

In studying radiation effects in patients with tumors of the central nervous system, the authors have noted comparable effects to those seen in the experimental animal. At present studies are being undertaken to determine specific tumor doses of radiation which will not produce these deleterious side effects on normal brain substance. They feel that previous investigators have failed to examine the irradiated brain tissue at frequent enough entervals to observe the sequence of pathological events that occur. Only in this way can it be shown that the central nervous system is actually responsive to lower roentgen ray dosages.—*Michael J. Healy, M.D.*

RADIOISOTOPES

Lederman, M., and Greatorex, C. A. A cobalt 60 telecurie unit. *Brit. J. Radiol.*, Oct., 1953, *26*, 525–532.

Teletherapy with radium was introduced at The Royal Cancer Hospital, London, England in 1929. First, two 1 gram units were used, then, in 1936, one of the 1 gram units was changed into a 5 gram unit. With availability of additional radium, in 1947 all radium was assembled in a single 10 gram unit which was called the "Bryant Symons 10-gramme Radium Beam Unit." This apparatus, apart from having a larger radioactive source, incorporated several mechanical and engineering advances upon the original 1 gram and 5 gram models.

In February, 1952, a 3.25 curie cobalt 60 unit was installed, by housing the radioactive cobalt source in a second Bryant Symons apparatus. Practical experience with these two units showed that the Bryant Symons model, in spite of its more modern design, still suffered from the disadvantage of not having all the controlling handwheels within easy reach of the operator setting up the patient.

In the present paper the authors describe in detail the modifications made to correct this disadvantage. They also discuss the contribution of five new uranium nozzles which they have added (a) to increase the technical flexibility, (b) to lessen the discomforts and risks of treatment and (c) to adapt the technique of treatment to the natural history of the disease treated. Two of these nozzles give triangular fields of 8 by 6 cm., two pentagonal or notched fields of 8 by 5 cm. and one a rectangular field of 5 by 2 cm.

The availability of two different radioactive sources has permitted the authors to make a series of comparative measurements. The results were found to be in general agreement with those of Merewether, Osborn and Wyard, published in 1952 (*Acta radiol.*, 1952, *37*, 459–468). This report deals only with the measurements of the distribution of the radiation from the Co^{60} source in water, as it is affected by the new field shapes, and with the comparative study of the isodose curves obtained with tungsten and uranium applicators.

In concluding, the authors draw attention to the very real hazard which may result from possible contamination by oxidation of the cobalt when this element is used as the radioactive source. The cobalt oxide is formed as a dust and may leak out, contaminating not only the source assembly but also the amtosphere. It is therefore important that the source be completely sealed at all times. As a further precaution the possibility of sealing the cobalt sources in aluminum containers before activation in the pile is now being investigated by the Atomic Energy Research Establishment of Harwell.—*T. Leucutia, M.D.*

Rall, J. E., Sonenberg, Martin S., Robbins, Jacob, Lazerson, R., and Rawson, Rulon W. The blood level as a guide to therapy with radioiodine. *J. Clin. Endocrinol. & Metabol.*, Nov., 1953, *13*, 1369–1377.

Radioiodine has been shown to be an effective therapeutic agent for hyperthyroidism, but the dosimetry remains relatively unpredictable and difficult to evaluate. Sources of error are estimation of gland weight, inhomogeneity of distribution, and variability in the length of time the radioiodine will remain in the gland. Estimate of the time-distribution factor can be obtained from a preliminary tracer study, but this is prolonged, and often differs from the subsequent distribution of the therapeutic dose.

The uptake of a tracer dose by the thyroid, and a single blood level of labelled hormone at forty-eight hours should give a useful estimation of iodine turnover, from which the therapeutic dose can be calculated. If the therapeutic dose is given shortly after the tracer (within two weeks) the turnover pattern is usually similar, making the dosage calculation applicable.

To obtain specific constants for the dosage equation, the data from 43 treated patients were analyzed. These 43 patients were those, of 116 treated at Memorial Hospital in New York City from 1949 to 1952, who became euthyroid following a single dose of radioiodine.

The complete equation derived is:

$$\text{Dose (in microcuries)} = \frac{100(110+27b)\times G}{U}$$

Where B = concentration of I^{131} in whole blood at forty-eight hours.
G = weight of thyroid in grams, and
U = percentage uptake of tracer dose at forty-eight hours.—*R. Kenneth Loeffler, M.D.*

Burrows, Belton, A., Ross, Joseph F., Dell, Elisabeth, S., Graham, Dorothy E., and Hammack, David F. The thyroidal uptake of stable iodine compared with the serum concentration of protein-bound iodine in normal subjects and in patients with thyroid disease. *J. Clin. Endocrinol. & Metabol.*, Nov., 1953, *13*, 1358–1368.

In general, the percentage uptake of a tracer dose of radioiodine by the thyroid is a good index of thyroid function. This is true unless the dietary intake of stable iodine is grossly altered, or the thyroid function has been altered by treatment.

The tracer uptake percentages and protein bound iodine concentrations correlated closely in 85 untreated patients referred with a question of thyroid disease. Normal values were 10–50 per cent iodine

uptake, and 3.5–7.0 micrograms per cent in serum. The correlation was poor in 112 patients who had been treated for hyperthyroidism.

The uptake of total (stable) iodide by the thyroid was calculated in some patients from the uptake of tracer radioiodide, and the specific activity of the serum iodide during the uptake period. The specific activity in the serum was estimated from serial determinations of the specific activity of iodide being excreted in the urine, since these should be equal at any given time. In 25 treated patients, studied because the per cent uptake of a tracer dose was higher than average for the corresponding protein bound iodine concentration, an exponential relationship was noted between total iodide uptake by the thyroid and the circulating protein bound iodine level, a threefold increase in iodide uptake corresponding to an increase of 3.5 micrograms per cent of serum iodine.

Several subsidiary studies are reported relating to the availability and utilization of circulating iodide for the formation of thyroid hormone.—*R. Kenneth Loeffler, M.D.*

Wainwright, W. W., Butt, Byron G., Hauptfuehrer, J. Donald, and Dute, Harold L. Deposition of radioactive iodine in teeth of persons treated for disease of the thyroid gland. *J. Am. Dent. A.*, Dec., 1953, *47*, 649–655.

Using radioactive tracers, it has been previously demonstrated with freshly extracted human teeth that different types of salts show various degrees of penetration through the intact or damaged enamel. Bartelstone first showed that teeth of patients previously treated with large doses of radioactive iodine could be used to demonstrate some of these phenomena.

The authors studied the teeth of 5 patients who needed dental extractions and who were also treated with large doses of I^{131}. A total of 25 teeth were extracted from five hours to nineteen days following the oral administration of the radioactive material. In vitro penetration studies were all confirmed in the human subjects where it was demonstrated that I^{131} will rapidly and diffusely penetrate intact normal enamel, dentin and cementum as well as enamel lamellas and damaged portions of the tooth.

It is interesting to note that no differences in the amount of localization could be detected by roentgenographic techniques in teeth extracted five hours or nineteen days after the administration of I^{131}. The authors further showed that there is practically no turn-over of I^{131} in teeth, at least in the first two weeks.—*J. P. Storaasli, M.D.*

Delarue, J., Tubiana, M., and Dutriex, J. Cancer de la thyroide traité par l'oide radioactif; terminaison par une leucémie aigue près une amélioration importante. (Cancer of the thyroid treated by radioactive iodine; termination with acute leukemia after marked improvement.) *Bull. Assoc. franç. l'étude cancer*, 1953, *40*, 263–271.

The authors report a case of a sixteen-year-old girl for whom, in 1944, a radium collar was applied to an inoperable recurrence of a thyroid cancer with right cervical lymph node metastases. The dose was 35,000 mg. hr. A partial hemithyroidectomy on the right side had been performed 6 months previously. In spite of this treatment the tumor mass slowly increased in size. In 1947 pulmonary metastases were noted. Subsequently enlarged lymph nodes appeared in the left neck and right axilla. Beginning in 1950 a total of 324 mc. of I^{131}, divided into 4 doses, was administered over a period of 13 months, with some temporary local improvement. Hematological studies showed a persistent leukopenia beginning at the time of the radium therapy. After the last I^{131} treatment a moderate anemia also appeared and this gradually got worse. In August 1951 bleeding from the gums occurred. The bleeding tendency and the anemia with granulocytopenia persisted. There was no new lymphadenopathy, no hepatosplenomegaly. In 1953 a sternal marrow puncture revealed 35 per cent leukoblasts. The patient died a few weeks later with acute leukemia.

The authors believe this case represents a radiation induced acute leukemia. In support of this thesis they refer to roentgen-ray induced leukemia of mice and to the increased incidence of leukemia in radiologists and in the survivors of atom bomb explosions. They calculated that the dose to the center of the trunk was 455 r from the radium therapy and 1272 rad from the I^{131}. Their case demonstrates that the risk of leukemia can occur with radiation doses at a therapeutic level. The latent period is 4 to 20 years. The accumulation of the radiation doses and their repetition are the responsible factors in this case.—*Sidney M. Silverstone, M.D.*